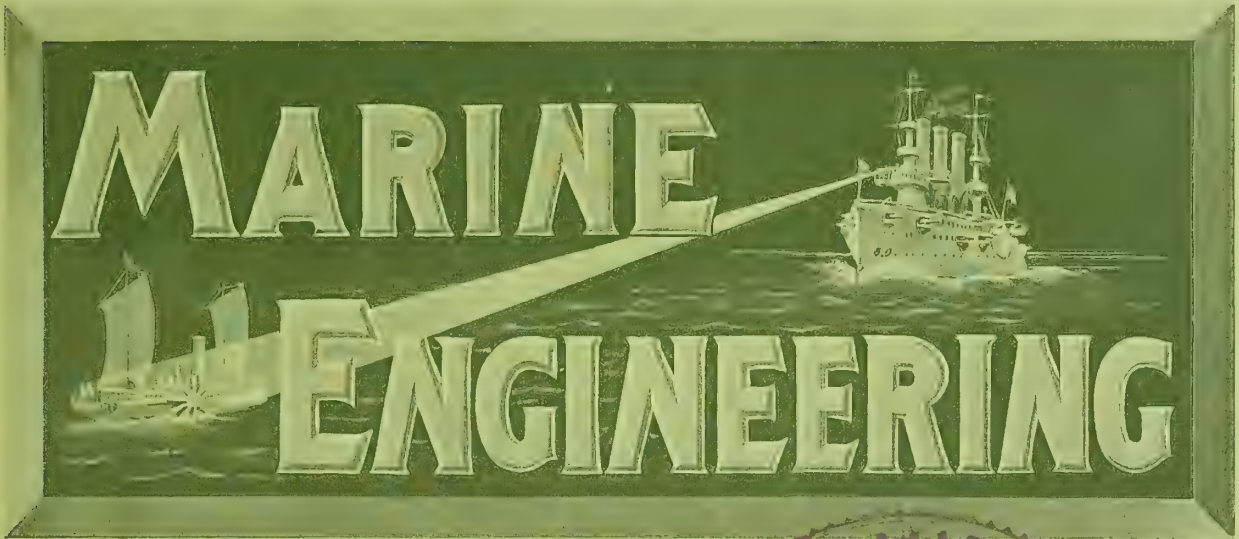




Vol. III.

NEW YORK, APRIL, 1899.

No. 4.

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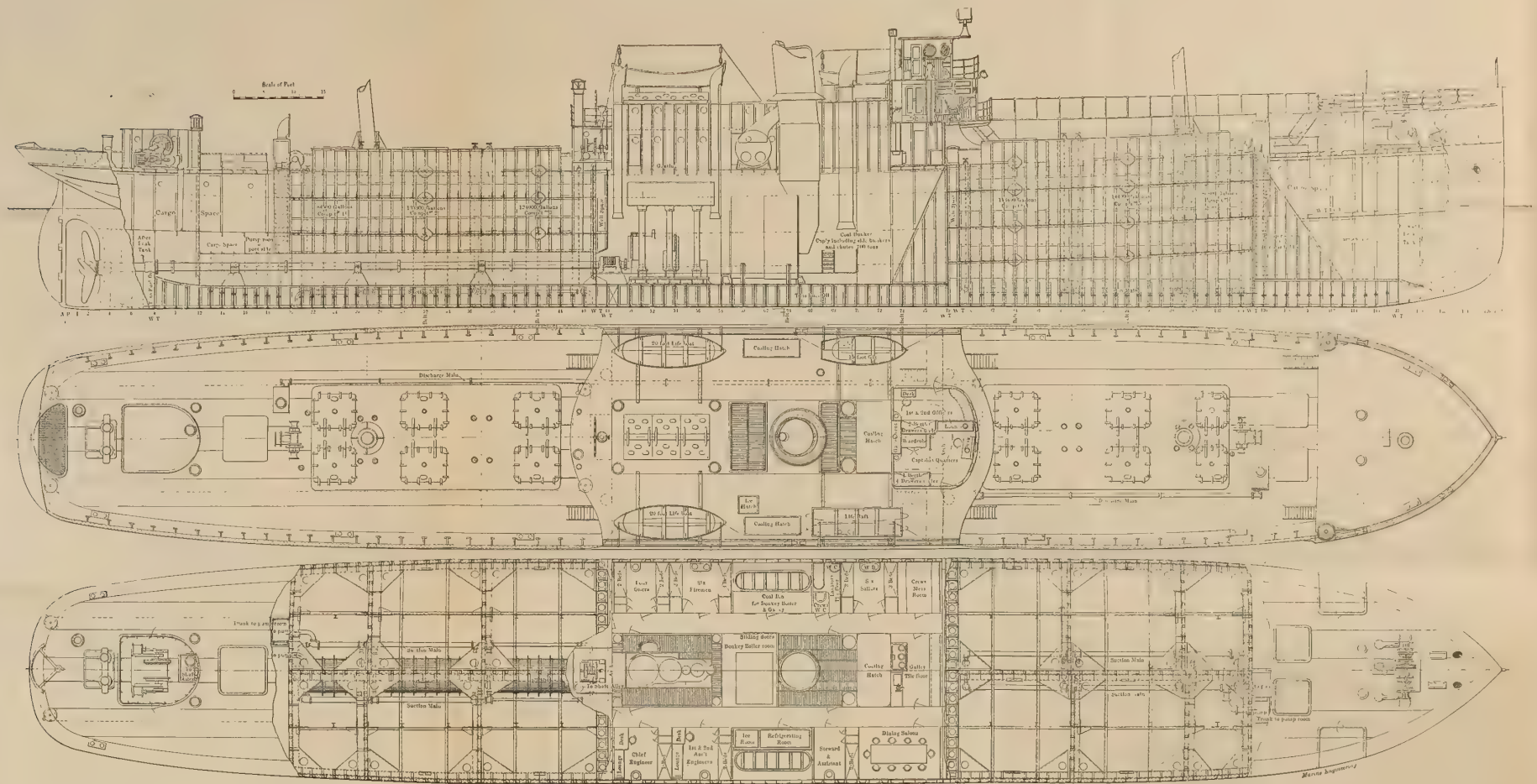
STEEL SCREW STEAMER ATLAS FOR STANDARD OIL CO., TO CARRY 720,000 GALLONS OIL IN BULK.

Designed by John Haug, Consulting Engineer, Philadelphia, Pa.

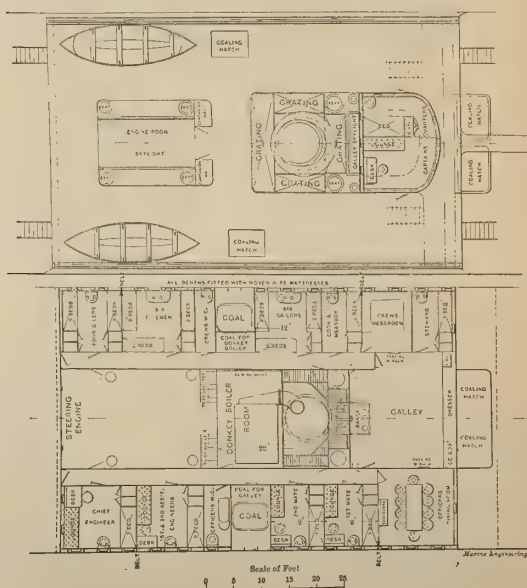
Built and Engineed by Delaware River Iron Shipbuilding and Engine Works, Chester, Pa.

(Supplement to Marine Engineering April, 1899. See Pages 27, 28, 29 and 30.)

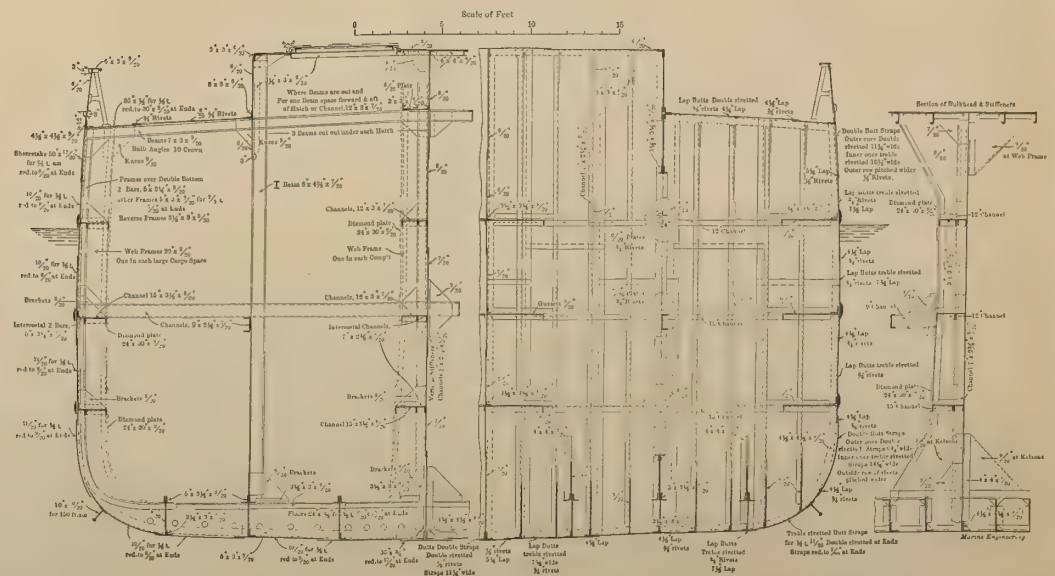
INBOARD PROFILE, DECK AND HOLD PLANS.



ARRANGEMENT OF LIVING QUARTERS.



CROSS SECTIONS.





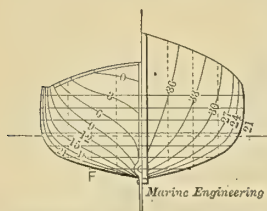
MARINE ENGINEERING.

Vol. 3.

NEW YORK, APRIL, 1899.

No. 4.

STEAM YACHT WANDA, BUILT BY POLSON IRON WORKS, TORONTO, CANADA.



mensions of the vessel are: Length, extreme, 70

Our engravings show the very handsome composite steam launch Wanda, built last summer by the Polson Iron Works, of Toronto, Canada, for Timothy Eaton, one of the leading merchants of that city. The di-

the frames, which are spaced 16 in. centers, and the same material is used for the keelson and bilge stringers, double back to back, and also for the top height stringer. A plate sheer strake and plate deck stringer completes the use of steel. The whole is planked with clear British Columbia pine 1 3-16 in. thick, fastened with cheese-headed bolts recessed into the planking and plugged. The forecastle and poop decks are of clear white pine. Internal wood work is all of bright cherry and red oak, upholstered in maroon plush, velvet and corduroy, with Wilton carpets. The railings and stanchions are of brass, nick-



CANADIAN STEAM YACHT WANDA ON LAKE MUSKOKA, ONTARIO.

ft.; length, water line, 60 ft.; beam, extreme, 8 ft. 3 in.; draught aft, 3 ft. 6 in.; and displacement, 24,000 lb.

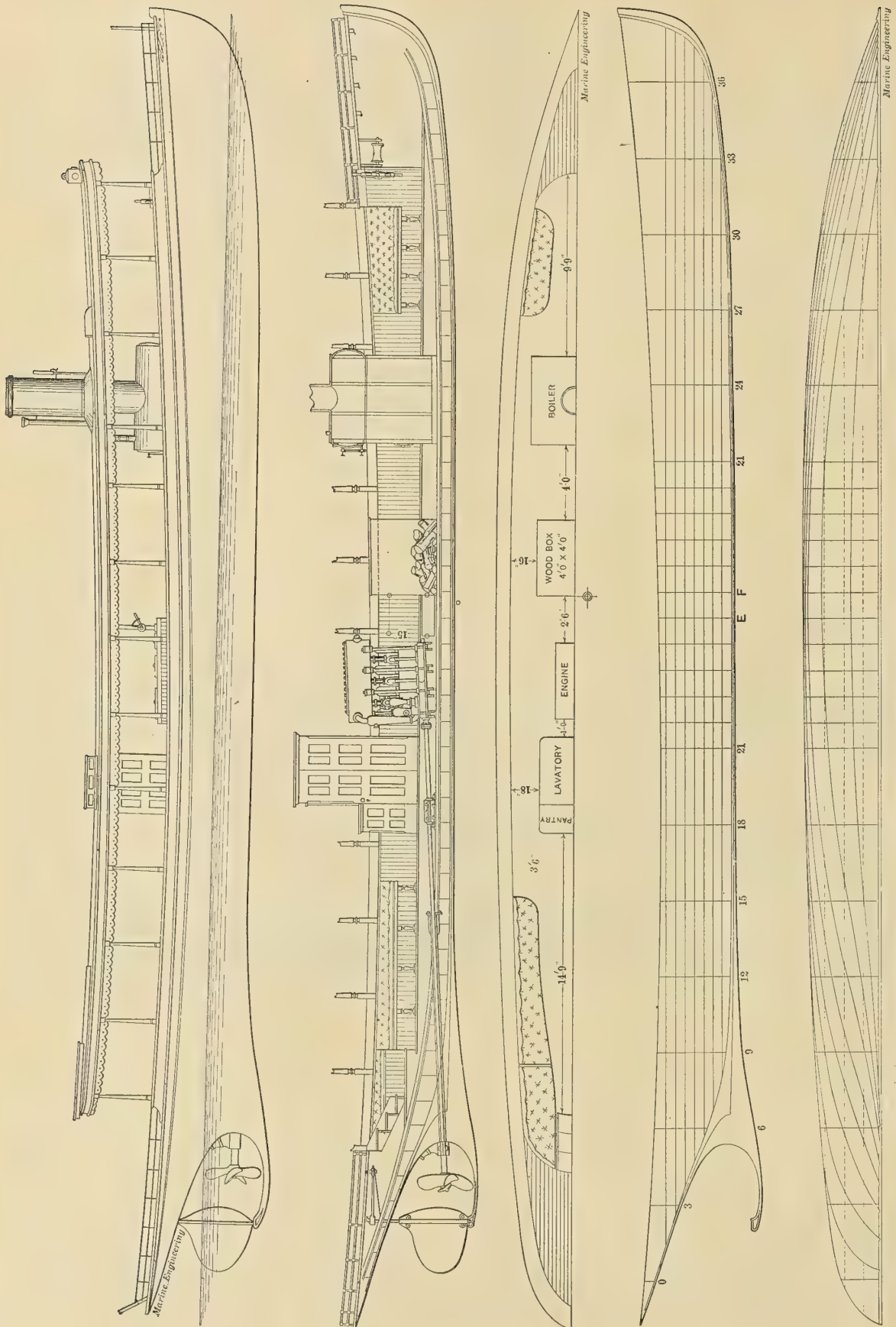
The machinery equipment includes a triple-expansion engine, driving a single screw, and having cylinders 5 1-2 in., 8 1-2 in. and 14 in. dia., and 8 in. stroke. The running speed is 400 revolutions per minute. A Mosher water-tube boiler furnishes steam at 200 lb. pressure. This boiler measures: Length, 48 in.; width, 48 in.; height, 56 in. It has 11 ft. 8 in. of grate surface and 400 sq. ft. of heating surface.

Angle steel 2 1-4 by 1 1-2 by 3-16 in. is used for

eled, and this makes a very pretty contrast with the bright upholstery and wood work. Shade and storm curtains of striped duck are fitted all around the boat.

On Lake Muskoka, Ont., the Wanda is used by the owner to connect between the railway wharf at Gravenhurst and his summer residence at Windermere, on the lake, a distance of 25 miles. The vessel was designed to cover this in an hour and a half, and does so regularly, using wood for fuel. When let out she has made the run in an hour and twenty minutes.

The launch was designed by W. E. Redway, N. A., who also superintended its construction.



PLANS AND LINES OF THE S. Y. WANDA, BUILT BY THE POLSON IRON WORKS FOR T. EATON, OF TORONTO, ONTARIO.

PERFORMANCES OF U. S. S. OREGON DURING THE RECENT SPANISH WAR PERIOD.*

BY P. A. E. CHARLES A. E. KING, U. S. N.

MANILA, March 18, 1899.

SECRETARY OF THE NAVY, Washington, D. C.:—
The Oregon and the Iris arrived to-day. The Oregon is in fit condition for any duty.

DEWEY.†

The U. S. S. Oregon, attached to the Pacific Station, was docked at the Naval Station at Puget Sound, State of Washington, on January 4, 1898, and, having had the usual docking repairs made, her bottom cleaned and painted, and all outboard fittings examined and found in good condition, was floated on February 16, 1898.

What proved to be the most remarkable voyage in the history of battleships began at 6:10 A. M., on

was the engineer officer on duty at that time. The engines were worked by signals from deck from 6:40 to 6:50 A. M., when the signal was received "Ahead full speed." From that time until 8:30 P. M. on May 24, when the engines were stopped and the Oregon anchored off Jupiter Inlet, Florida, this remarkable machinery, cared for and manipulated by an engineer department whose perfect organization and rare ability stand pre-eminent, worked without a serious casualty.

The history of this voyage, as given in the steam log books, is a story of ceaseless vigil and painstaking care on the part of the engineer personnel. Countless small defects, inseparable from such a run under steam, were detected and at once remedied, and no opportunity was lost to maintain the efficiency of the motive machinery and its dependencies by intelligent adjustments at the proper time. The devotion



U. S. S. OREGON TAKING HER POSITION IN LINE AT THE NAVAL REVIEW, NEW YORK.

March 6, 1898, when the main engines, having been tried under steam, were reported ready to the Chief Engineer by P. A. Engineer C. N. Offley, U. S. N., who

*From the Journal of the American Society of Naval Engineers.

†Dispatch from Admiral Dewey announcing the successful termination of another long ocean voyage of the *Oregon*, from New York to Manila, via Cape Horn, a distance of 20,000 nautical miles. The article here printed refers to the famous voyage of the Oregon from the Pacific to the Atlantic coast.—Ed.

to duty of officers and men and the willing co-operation of all in striving to maintain the vessel's speed and efficiency merit the greatest praise.

Life below the protective deck of the Oregon after March 6, 1898, was a life of hardship and toil, a life spent in a heated atmosphere where the roaring of the furnaces and the leaping of the massive engines might well have afforded some excuse for confusion and lack of purpose among those whose days and nights were passed there. Not so, however. These

men of the engineer department rose equal to the emergency and went about their duty calmly, earnestly and with wonderful intelligence. The organization was perfect and the execution of the task set faultless. On more than one occasion when the labors of the men before the furnaces seemed to them to go for naught, and they felt all but discouraged because the steam would not "go up," the engineer officers, discarding their uniforms, jumped among them, fed the furnaces with their own hands, and, by force of this example, so encouraged the firemen that, with cheers, they redoubled their efforts, and the good ship sped through the water at a faster pace. This is the spirit that imbued the men of the Oregon, and this the work that brought to a successful end the most remarkable run ever made by a battleship.

The voyage was made in eight stages, as follows:

- 1st. From Puget Sound Naval Station to San Francisco.
- 2d. From San Francisco to Callao.
- 3d. From Callao to Port Tamar in the Straits of Magellan.
- 4th. From Port Tamar to Punta Arenas.
- 5th. From Punta Arenas to Rio de Janeiro, Brazil.
- 6th. From Rio de Janeiro to Bahia, Brazil.
- 7th. From Bahia to Barbadoes.
- 8th. From Barbadoes to Jupiter Inlet, Florida.

The ship was coaled at Puget Sound Naval Station, San Francisco, Callao, Punta Arenas, Rio de Janeiro and Barbadoes. The kind of coal used during each run is given in the accompanying performance table, as are also the distances run from port to port.

The complement of the engineer department was as follows:

Chief Engineer R. W. Milligan, U. S. N.	
Passed Assistant Engineer C. N. Offley, U. S. N.	
Assistant Engineer J. M. Reeves, U. S. N.	
Assistant Engineer Frank Lyon, U. S. N.	
Naval Cadet, Engineer Division, H. N. Jenson, U. S. N.	
Naval Cadet, Engineer Division, W. D. Leahy, U. S. N.	
Chief machinists	5
1st class machinists	3
2d class machinists	2
Yeoman	1
Boilermaker	1
Blacksmith	1
Coppersmith	1
Water tenders	6
Oilers	8
1st class firemen	14
2d class firemen	14
Coal passers	40

A total of officers and enlisted men of 94. It is interesting to compare this number with the total engineer force employed by the Union Iron Works upon the official trial trip of the Oregon, when the number on duty was 161 men.

The voyage may be considered to have ended when the ship dropped anchor at Jupiter Inlet on the night of May 24, and the record given here closes at that time. Still further honor awaited this wonderful ship, however. At 3:57 in the morning of May 25 the engines moved ahead slowly and the Oregon began her journey to Key West, where she arrived the following day shortly after 7 A. M.

Ordinarily, after a run of more than 14,500 knots, a great many repairs would be found absolutely necessary even to a cruiser, and several weeks would not

be considered too long a time to spend in rehabilitating the engines and boilers of any ship after such extraordinary service. But the Oregon coaled, rapidly completed a few adjustments of machinery, repaired a few minor defects, and at 1:04 in the morning of May 29, less than three days after her arrival, steamed away from Key West to add her strength to that of our fleet off Santiago de Cuba.

Her part in the battle of July 3, 1898, which resulted in the annihilation of the Spanish fleet under Admiral Cervera, is now a matter of history. If any further evidence is needed than that already given of the qualities of the Oregon, and of her personnel, the following quotations will undoubtedly furnish it:

"The Oregon, steaming with amazing speed from the commencement of the action, took first place." (Official report of Rear Admiral W. T. Sampson, U. S. N., upon the battle of July 3, 1898.)

"The fine speed of the Oregon enabled her to take a front position in the chase, and the Cristobal Colon did not give up until the Oregon had thrown a 13-in. shell beyond her. This performance adds to the already brilliant record of this fine battleship and speaks highly of the skill and care with which her admirable efficiency has been maintained during a service unprecedented in the history of vessels of her class." (Ibid.)

"The Oregon, having proved *vastly faster than the other battleships*, . . . continued westward in pursuit of the Colon." (Official report of Commodore W. S. Schley, U. S. N., upon the battle of July 3, 1898.)

"I cannot close this report without mentioning in high terms of praise the splendid conduct and support of Captain C. E. Clark of the Oregon. Her speed was wonderful and her accurate fire splendidly destructive." (Ibid.)

"The two remaining vessels were now some distance ahead, but our *speed had increased to 16 knots*, and our fire . . . soon sent . . . the Viscaya to the shore in flames." (Official report of Captain C. E. Clark, U. S. N., commanding the Oregon, upon the battle of July 3, 1898.)

"As these vessels (the Spanish) were so much more heavily armored than the Brooklyn they might have concentrated upon and overpowered her, and consequently I am persuaded that, but for the way her officers and the men of the Oregon steamed and steered the ship and fought and supplied her batteries the Colon, and perhaps the Viscaya, would have escaped." (Ibid.)

"The Oregon was keeping up a steady fire and was coming up in the most glorious and gallant style, *outstripping all others*. It was an inspiring sight to see this battleship, with a large white wave before her, and her smokestacks belching forth continued puffs from her forced draft. We were making fourteen knots at the time, and the Oregon came up off our starboard quarter at about 600 yards and maintained her position, though we soon after increased our speed to 15 knots, and just before the Colon surrendered were making nearly sixteen." (Official report of Captain F. A. Cook, U. S. N., commanding the Brooklyn, upon the battle of July 3, 1898.)

U. S. S. OREGON.

Bunker capacity, 1,590 tons of 43.5 cubic feet to the ton.

Date.	Hours.	Speed. Knots per hour.	Total coal expenditure for 24 hours. Tons.	Knots.		Coal endurance.		Months out of dock.	Wind		Sea.	Boilers in use.	Kind and quality of coal.	Total knots logged.	Remarks.
				Per day.	Per ton of coal.	In days.	In knots.		Direction.	Force.					
March 6-9, 1898.....	72.	11.48	69.74	275.57	3.95	22.7	6280.	$\frac{3}{8}$	11	4	S. to M.	3 main.	Comox; good.	826.7	Puget Sound to San Francisco.
Mar 19-Apr 4, 1898...	375.	10.956	61.80	263.744	4.267	25.7	6784.	1	6	3	S. to M.	3 main.	Comox; good.	4,112.1	San Francisco to Callao.
Apr. 7-16, 1898.....	213.6	11.935	88.73	286.45	3.288	17.9	5228.	$1\frac{1}{8}$	3	3	S. to M.	{ 3 main.* 4 main.* }	Cardiff; good	2,549.4	Callao to Port Tamar.
Apr. 17, 1898, (8 A. M. to 5 P. M.) }	9	14.6	176.64	350.4	1.98	9.0	3148.	2	Var.	2	S.	4 main.	Cardiff; good.	131.4	Port Tamar to Punta Arenas. Steaming through Strait of Magellan. Blowers in open fire-rooms. Av. I.H.P. = 6,450. Punta Arenas to Rio de Janeiro. Follow- ing U. S. S. <i>Martina</i> and sailing speed to hers.
Apr. 21-30, 1898.....	221.25	10.159	70.30	243.78	3.467	22.6	5512.	2	5	3	S. to M.	4 main.	Cardiff; good.	2,247.7	
May 5-8, 1898.....	74.25	10.09	74.85	242.16	3.234	21.2	4942.	$2\frac{3}{8}$	2	3	S.	4 main.	{ English bituminous; fair. }	749.7	From anchor off Rio to Bahia, Brazil.
May 10-17, 1898.....	193.25	11.544	77.00	276.77	3.594	20.6	5714.	$2\frac{3}{8}$	9	3	S.	4 main.	{ English bituminous; fair }	2,228.0	Bahia to Barbadoes.
May 19-24, 1898.....	141.5	11.773	81.14	282.55	3.482	19.5	5536	3	9	3	S.	4 main	{ English and Welsh bituminous; fair. }	1,665.9	Barbadoes to Jupiter Inlet, Florida.

* Half time.

Total knots of above performances.....	14,510.9
Total hours of above performances.....	1,299.85
Total tons of coal used, above performances.....	4,009.38
Knots per hour (all runs).....	11.16
Knots per ton (all runs).....	3.61

Greatest displacement, April 7.....	11,857 tons.
Least displacement, March 9.....	10,417 "

The engineer officers on board the Oregon during this memorable engagement, and their stations, were as follows:

Chief Engineer R. W. Milligan, in charge of machinery.
 Passed Assistant Engineer C. N. Ottey, starboard engine-room.
 Assistant Engineer J. M. Reeves, port engine-room.
 Assistant Engineer F. Lyon, in charge of fire-rooms.
 Naval Cadet H. N. Jensen, after hydraulic pump-room.
 Naval Cadet W. D. Leahy, forward hydraulic pump-room.
 Acting Assistant Engineer T. C. Dunlap, starboard engine-room.

The number of enlisted men in the engineer department was 114.

Thus we see that the Oregon, four and one-half months out of dock, with an engineer complement of 121,* was able, almost immediately after a voyage of more than 15,000 miles, to go into battle and fight successfully, while making a speed of 16 knots per hour. Her contract trial speed was 16.791 knots per hour, and the engineer complement at that time 161, as previously stated.

The record of this peerless battleship and the eff-

ciency of her officers and crew stand unequaled in the history of the world's navies, and shed new lustre upon the skill of American shipbuilders and mechanics, and upon the intelligence and devotion to duty of the personnel of the American Navy.

A table of performances is given herewith.

*This number is an increase of 27 over those on board during the voyage from California to Florida; the additional officer and men having been ordered on board after the arrival at Key West, to meet the war conditions.

MARYLAND STEEL CO.'S SHIPBUILDING PLANT AT SPARROW'S POINT, MARYLAND.

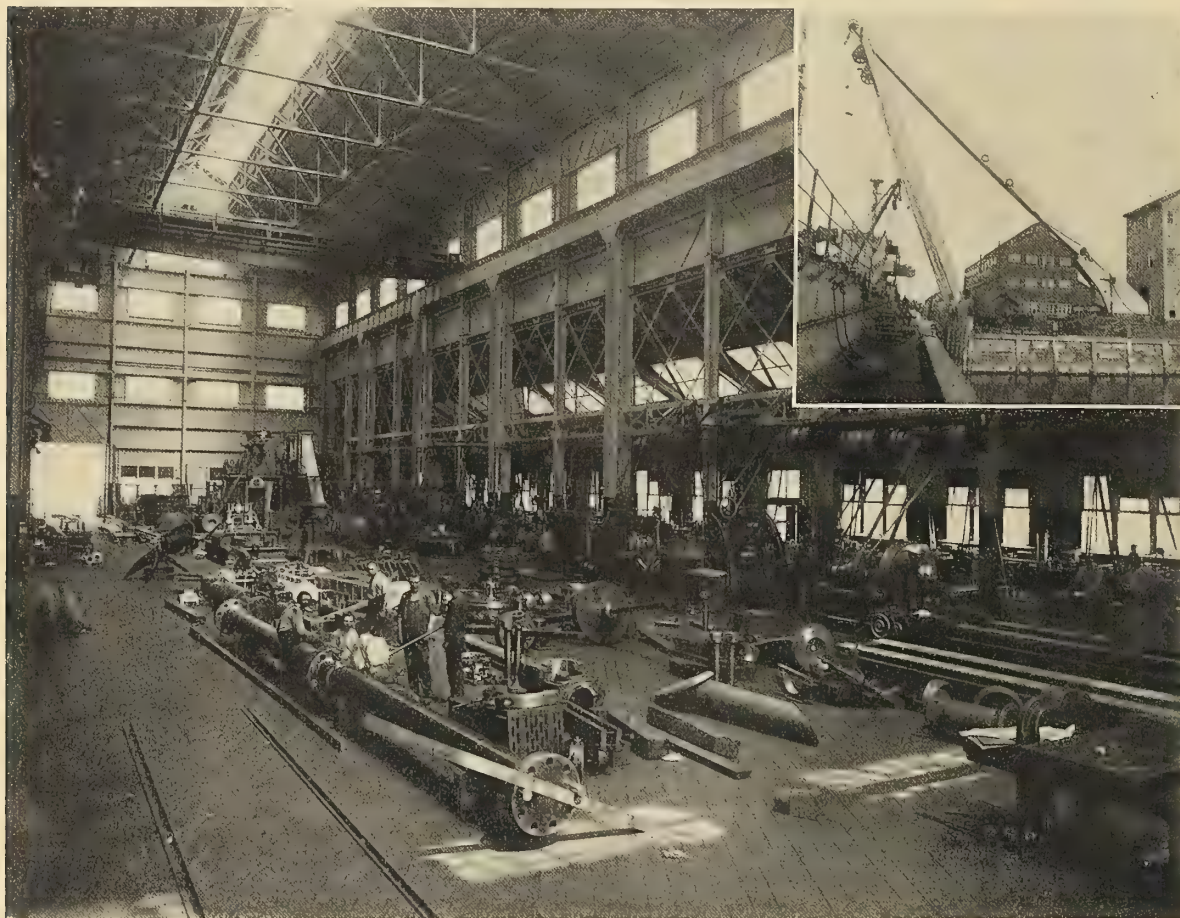
The ship yard of the Maryland Steel Company, at Sparrow's Point, Md., which was built as an adjunct to the steel plant in 1891, and which, in 1895, on account of scarcity of marine work, went into bridge and structural work, resumed ship building operations last fall, securing for the first contract three of the torpedo-boat destroyers provided for in the Naval programme of May, 1898.

The yard, which has a water frontage of about 2,000 ft., consists of a ship shed, machine and erecting

strips, in rolls, are preserved, so that the complete mould loft dimensions are at any time available. When operations at the yard were resumed the joiner shop floor was utilized for a mould loft for some of the vessels, but the old method of fairing in the drawing room has been restored for more recent contracts.

The iron gauge system for bending frames is used instead of wood moulds. When the frames have cooled off they are ready to be put in place, the punching having been done from the straight bar before heating.

The heating furnaces are shown in one of the accompanying photographs. The plate furnace is built in the usual way of brick, and the angle furnace of



VIEWS SHOWING INTERIOR OF ERECTING SHOP AND 125-TON SHEERS, WITH TURRET STEAMER ALONGSIDE.

shop, blacksmith shop, copper shop, joiner shop and boiler shop, and a complete lumber working plant, with Sturtevant dryer. The foundry and pattern shops are the same as used for the other branch of the works and are about a half mile from the ship yard.

Plans are projected for a dry dock, and it is expected that work on this will be hurried.

A peculiarity of the plant, as originally laid out, was that no mould loft was provided, the fairing being done on large scale drawings in the draughting rooms. The offsets were given to the loftsmen, instead of in figures or on poles, on long strips of tough paper, and transferred directly to the scribe board. These

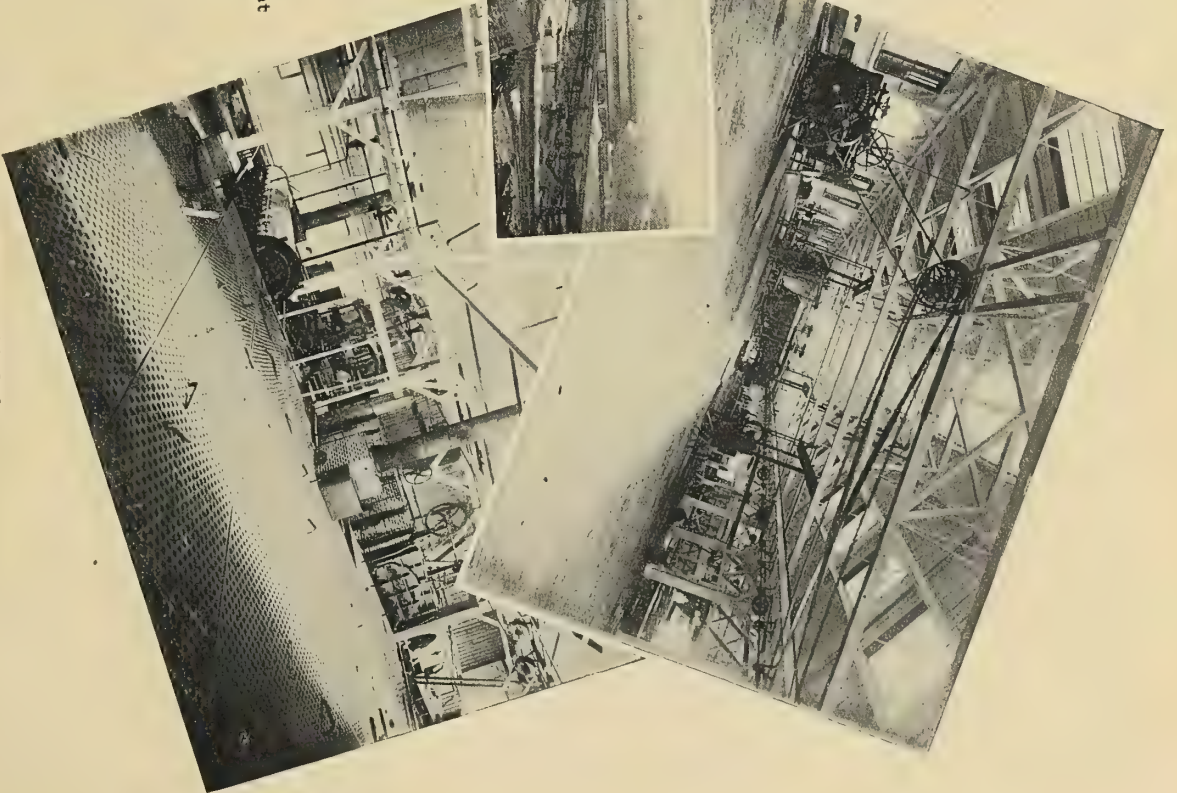
plates, cylindrical in form. Oil is used for fuel, with much success, the advantages being quick firing and the regulation or stopping off entirely of the heat, at any part, thus rendering unnecessary the protection of scarfs and thin places with clay, as in the old method. The fires are closed off each night and started an hour before the yard begins next morning.

There is a galvanizing tank for the smaller work, but most of the galvanizing will be done by contract. The cleaning of plates is accomplished by the recently established "sand blast process," thus saving the plates from the dangers of pickling.

The shops and stock yard are fitted with electric traveling cranes, and there is a complete hydraulic



Views
at
Sparrow's Point
Shipyard.



Interior of joiner shop.
Radial countersink in shipshed.

General view of yard from furnaces—rail mill and Bessemer plant in foreground.

Interior of shipshed.
Angle and plate furnaces.

and pneumatic system for riveting, punching, drilling, caulking, and similar operations.

Punches, sheers, planers and all machines in the ship shed are to be driven independently with electric motors. Some are driven independently now by steam, but motors have been ordered for all. This enables over-time on single machines to be carried out at small cost, and permits different speeds on particular or ordinary work, to say nothing of the advantage in case of a break down in the engine room.

The foundry, too, is provided with an electric traveling crane, the capacity of which is 50 tons, also four 15-ton hydraulic jib cranes, and hydraulic elevators.

The sheers, shown in one of the illustrations, were used to transfer the 19-in. Krupp gun for the World's Fair from the steamship in which it crossed the ocean to the special flat car built for the transportation of the gun from the coast to Chicago. This sheers has been tested to a maximum load of 146 tons net. Hydraulic power is used to operate the sheers, at a pressure of 1,600 lb. to 1,800 lb. per square inch.

The first of the contracts secured, as already noted, was for the construction of three torpedo-boat destroyers for the Navy, the names of which are *Trustun*, *Whipple* and *Worden*, officially known as Nos. 14, 15 and 16, respectively. These boats, which are contracted for on the builder's design, resemble closely the Spanish destroyers *Furor* and *Terror*, and are 248 ft. long, 22 ft. 6 in. beam and 6 ft. draught on the load water line, with corresponding trial displacement of 433 tons. They will be fitted with triple-expansion engines, with cylinders 23 in., 34 in. and two 37 in. dia. and 22 in. stroke. With 240 lb. steam pressure they are expected to indicate 8,300 horse power and attain a speed of 30 knots.

In the yard the outside plating is now being put in place on a twin-screw freight and passenger steamer for the New Haven Steamboat Company, to be used for the Long Island Sound service. This steamer, which is practically a duplicate of the *Richard Peck*, is 325 ft. long over all; 48 ft. beam, moulded; 65 ft. over guards, and 17 ft. 9 in. deep, moulded. Her engines are triple-expansion, having cylinders 24 in., 38 in. and 60 in., with a stroke of 30 in. and steam pressure of 170 lb.

Work is also progressing on a seagoing tug for the Baker-Whiteley Company, of Baltimore, in dimensions: Length, 112 ft. between perpendiculars, 125 ft. over all; moulded breadth, 24 1-2 ft., and depth, 14 ft. Her engines will be triple-expansion, with cylinders 14 1-2 in., 23 1-2 in. and 39 in. dia. by 28 in. stroke; steam pressure, 175 lb., and about 800 I. H. P. This tug will carry powerful wrecking and fire pumps, an electric light plant, capstan and steam steering gear.

Two single-screw steamers for the Boston Tow Boat Company have been laid down. The dimensions of these boats are: Length, 324 ft.; beam, 47 ft., with a dead weight carrying capacity of 4,000 tons, to be fitted either as tramps or colliers. The engines are triple-expansion, with cylinders 21 in., 35 in. and 56 in., by 42 in. stroke and 1,400 I. H. P. Steam is supplied by two single-ended Scotch boilers. They will be fitted with complete outfit of hoisting winches, towing machines, and are to have the highest American classification.

In addition to these boats, there is also contracted for and building a floating dry dock for the Navy, to be 138 ft. wide and 545 ft. long, capable of taking on steamers even of the *Campania* class.

At present the shapes for vessels are rolled at the company's plant at Steelton, Pa., but the final plan will be to roll plates and shapes at Sparrow's Point.

The original and main part of the plant, to which, as has been said, the Marine Department was an addition, consists of foundries, pattern shop, boiler and machine shop, four blast furnaces, Bessemer plant, and rail mill with capacity of 1,600 tons of steel rails per day. Though the Bessemer plant is entirely independent of the blast furnaces, the general practice is to use the metal, transported in ladle cars directly, without reheating. The company at present, in addition to contracts in this country, is shipping rails to Ireland, India, China and Australia.

The ore used is received at the company's piers from Santiago de Cuba and Cartagena, Spain. The wharves are fitted with the coal loading device of the Link Belt Engineering Co. type.

Another contract, on which considerable interest centers, is one of the War Department for ten mounts for 12-in. rifled seacoast mortars.

The officers of the company are: President, F. W. Wood; General Agent, R. K. Wood; and the ship yard is in the hands of: General Manager, A. G. Wilson; Assistant General Manager, Rodgers Wilson, and H. A. Magoun, marine engineer. The Navy Department is represented by Wm. H. Varney, U. S. N., superintending constructor, and D. C. Redgrave, U. S. N., inspector of machinery.

For the foregoing particulars and the fine photographs of the yard and shops we are indebted to C. B. Brewer, a member of the staff of the resident U. S. naval constructor.

VIBRATIONS OF STEAMSHIPS AND METHODS OF BALANCING MARINE ENGINES—III.

BY C. H. PEABODY, B. Sc.

Mr. Yarrow has employed a method of balancing an engine with bob-weights, which can best be explained by certain simple preliminary examples, as in his

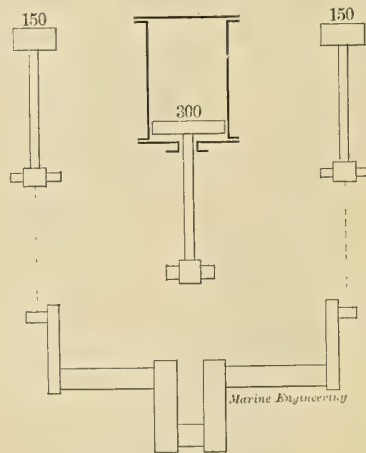


FIG. 9.

exposition of that method. Let Fig. 9 represent a single-cylinder engine and its crank shaft, which has

two overhung cranks at the ends. At equal distances from the cylinder are bob-weights that are driven by the overhung cranks. The weight of each bob-weight with its rod and crosshead is half the weight of the piston, piston-rod and crosshead, and each bob-weight connecting-rod has half the weight of the engine connecting-rod. With the overhung cranks opposite the engine crank the system of counterweighting is almost perfect, for it takes care of the transverse throw of the connecting-rod as well as the vertical acceleration of the reciprocating parts. This system of balancing would be perfect with a slotted crosshead; with a short connecting-rod the inequality of the accelerating forces at the top and bottom of the stroke is appreciable but is seldom of importance. It is not necessary to have the bob-weights equidistant from the engine cylinder; they may be at unequal distances, as in Fig. 10, provided their weights are properly proportioned. In Fig. 10 the right hand bob-weight and attached parts has half the weight of the left hand bob-weight and attached parts, for it is twice as far from the engine cylinder. The right hand overhung crank in this case should also have half the weight of the left hand crank, to preserve the balance of the crank shaft. In any case it will be sufficient to make the weights of the bob-weights (and

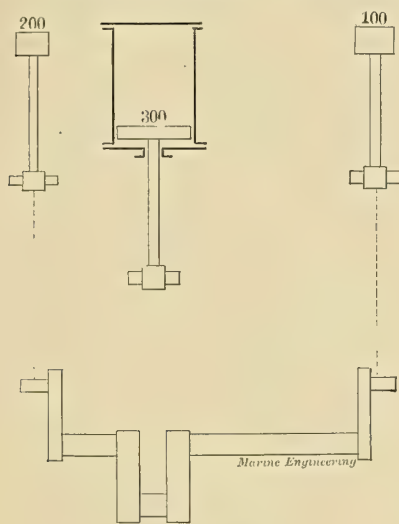


FIG. 10.

attached parts) inversely proportional to their distance from the cylinder of the engine. The connecting-rods should also have their weights inversely proportional to their distances if the transverse throw is to be balanced.

But it is not necessary to make the length of the overhung cranks the same as that for the engine itself. If the bob-weights in Fig. 9 are each made as heavy as the piston and its attached parts, then the overhung crank can be made half as long as the engine crank. For either Fig. 9 or Fig. 10 the length of an overhung crank and its bob-weight may be varied at will, provided that after such a transformation the product obtained by multiplying together the length of the crank and the weight of the bob-weight (and attached parts) is equal to the product of the original length and the original weight.

The preceding discussion affords the basis of the method of balancing proposed by Mr. Yarrow. He first chooses two convenient places near the ends of his engine at which he proposes to place all the bob-weights, or, rather, the equivalent of them. In Fig. 11

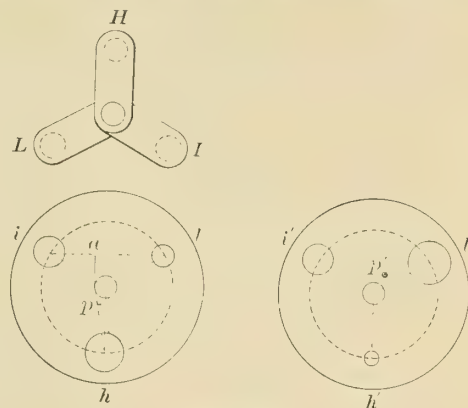


FIG. 11

let the cranks for the high-pressure, intermediate and low-pressure pistons be represented by H , I and L . Let h i l represent a circular disk clamped to the shaft forward of the engine, and h^1 i^1 l^1 be a similar disk abaft of the engine; all the diagrams in Fig. 11 are supposed to be viewed by a man who stands in front of the high-pressure cylinder and looks aft. Let us consider first the high-pressure piston. To counterbalance it we may use two cranks with bob-weights, which may be one forward of the engine and one aft. The forward bob-weight will be the larger, as it is nearer the cylinder under consideration. For counterbalancing the vertical accelerating force we may use instead, if we choose, two weights, as h and h^1 , which shall be placed opposite the crank H , one on the forward circular disk and one on the after disk. The sum of the weights h and h^1 will be equal to the weight of the reciprocating parts of the high-pressure cylinder, and their individual weights will be inversely proportional to the distance of the high-pressure cylinder to the circular disks. Of course if we finally use such revolving counterweights, we must accept the transverse throw at half stroke; however, the assumption of revolving counterweights is merely a device for working out the problem, and bob-weights will be used in the end. On the diagram the revolving counterweights are represented by circles with areas proportional to their weights. The intermediate piston can be counterbalanced by the two weights i and i^1 ; i being slightly the heavier because the intermediate cylinder is nearer the forward circular disk. Again, the low-pressure piston can be counterbalanced by the weights l and l^1 ; the latter being the largest weight on either disk, because the low-pressure piston is large and is near the circular disk. The circular disks may be assumed to be symmetrical, so that they are individually in balance, but one disk with its counterweights will of course be out of balance. To find the effect of centrifugal force acting on any unbalanced revolving body it is sufficient to know its weight, the position of its center of gravity, and, of course, the number of revolutions per minute. The

last term need not, however, be considered for our present purpose, as a proper counterbalancing will be equally efficacious at all speeds. Let us suppose now that p is the center of gravity of the system of these weights at h , i and l . This can be found by drawing the line $i-l$ joining the centers of the weights i and l , and dividing it at a , into parts which are inversely proportional to the weights at i and l ; and then by joining a to the center of h and dividing the line ah into parts that are inversely proportional to $i+l$ and h . In like manner p^1 is the center of gravity of the system of the weights i^1 , l^1 and h^1 on the aft disk. We may therefore counterbalance the engine by placing at p a weight equal to $h+i+l$, and at p^1 a weight equal to $h^1+i^1+l^1$. If we use that method, however, we shall have an undesirable cross throw when either the weight at p or the weight at p^1 is half way between the top and bottom of its revolution. To avoid this cross throw it will be necessary to use bob-weights. The forward bob-weight will have the center of its crank pin at p and the reciprocating parts will have a weight $h+i+l$; in like manner the after bob-weight will weigh $h^1+i^1+l^1$, and p^1 will be the center of the crank pin. If the weight $h+i+p$ is considered too large for convenience, half that weight may be used, provided the length of the crank be doubled; or the crank may be made any desirable length provided the weight be proportionally reduced. So also may the crank for the after bob-weight be made any desirable length by changing the weight to correspond. In general it will be found more convenient to use eccentrics to drive the bob-weights instead of cranks; this, however, will affect details of construction only.

For the sake of simplicity the statement for Yarrow's method takes account of the piston only; but the valves and valve gear for a marine engine have considerable weight, and it is desirable to include them in the balancing of the engine. In dealing with the valve gear Mr. Yarrow assumed the go-ahead eccentric to drive the valve and its rod, also half the link and one eccentric-rod. The backing eccentric was assumed to drive half the link and one eccentric-rod. He had thus in all nine sets of reciprocating parts, namely, three pistons and connected parts, three valves with rods and half links and three half links and eccentric-rods. This gave him nine counterbalancing weights at the forward location for counterbalancing, and nine at the after plane. The method, however, differed from that represented by Fig. 11 only in having more counterbalancing weights to reduce to one weight at the center of gravity of the system, and this meant only a little more calculation in the determination of the center of gravity.

For a special case of the engine for a torpedo boat Mr. Yarrow found that 740.25 lb. were required at the forward plane for counterbalancing, the center of gravity being 1.04 of an inch from the center of the shaft. The after weight was 1,178.15 lb., and its center of gravity was 0.28 of an inch from the center of the shaft. Mr. Yarrow used for the forward bob-weight 413 lb. with an eccentricity of 1 7-8 in., and for the after bob-weight 134 lb. with an eccentricity of 2 1-2 in. The total weight added was consequently only 547 lb., and the bob-weights were found to give little incon-

venience in the design or running of the machinery. To reduce the task of counterbalancing his engine Mr. Yarrow first counterbalanced the cranks before proceeding to discuss the reciprocating parts. In practice this method has been found to give very satisfactory results when applied to a torpedo boat,

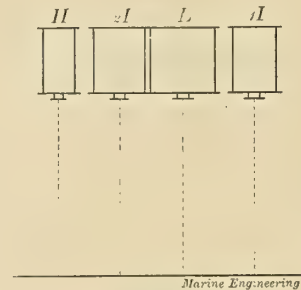


FIG. 12

which showed dangerous vibrations when the engine was unbalanced, and scarcely any when the engine was balanced.

This method when applied to the balancing of large engines is liable to demand very large bob-weights and large eccentrics for driving them. Schlick says that such a set of bob-weights for a certain engine which indicated 7,000 horse power weighed in all 44 tons, even though very large eccentrics were chosen, one eccentric having 12 in. eccentricity and the other 20 in. It is needless to say that the system was not applied to that engine.

Schlick has devised a very ingenious way of counterbalancing a marine engine when four cylinders are employed, which method virtually treats two of the pistons as bob-weights for counterbalancing the other two. He first suggests that the two large cylinders for a four-cylinder engine be placed in the middle and the smaller cylinders at the ends. Thus for a quadruple-expansion engine he would use the arrangement shown by Fig. 12, the cylinder beginning at the forward end of the engine being in the order of high-pressure, second intermediate, low-pressure and first intermediate. The chief difficulty of such an arrangement seems to be the large amount of piping

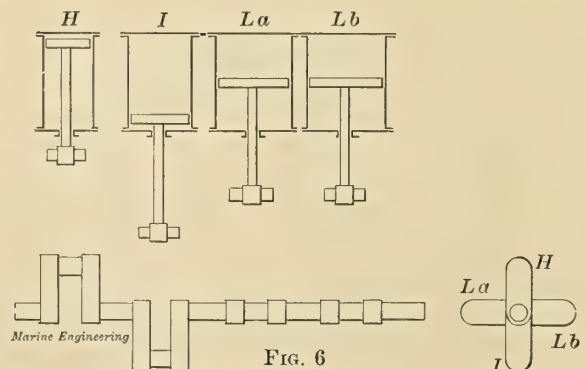


FIG. 6

needed, since the exhaust from the high-pressure cylinder must be led the whole length of the engine to reach the first intermediate cylinder; and the ex-

haust from the first intermediate cylinder must be led nearly as far to reach the second intermediate cylinder. A four-cylinder triple-expansion engine with two low-pressure cylinders can be similarly arranged with the two large cylinders in the middle. If it is considered desirable, the usual arrangement

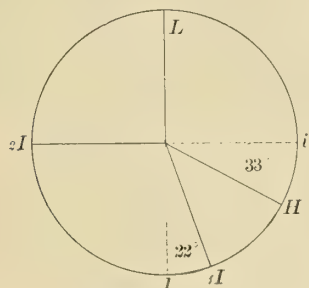


FIG. 13.

shown by Fig. 6 can be used, the order being, high-pressure, intermediate and then the two low-pressure cylinders, and the method may still be used.

Having the engine arranged as in Fig. 12, Schlick proposes that the cranks for the two inside cylinders be placed at right angles as indicated on Fig. 13, and then says that for the customary proportions for such a quadruple engine the high-pressure and first intermediate cranks will be at *H* and *l*, the first 33 deg. from a horizontal line and the second 22 deg. from a vertical line. These angles occur with an engine which has the following proportion of reciprocating parts:

High-pressure	1.
First intermediate	1.177
Second intermediate	1.261
Low-pressure	1.64

It will be seen that the succession of cranks starting at the high-pressure crank is as follows:

High-pressure to second intermediate.....	147°
Second intermediate to low-pressure.....	90°
Low-pressure to first intermediate.....	158°

It may be expected that the engine will give a very smooth turning motion to the shaft, almost as good an effect as the arrangement shown by Fig. 6. The

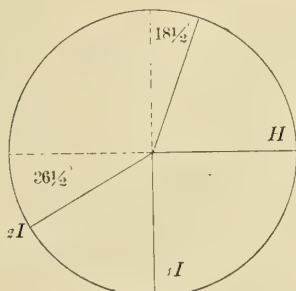


FIG. 14.

effect of the engine in starting cannot be considered so satisfactory, since the high-pressure crank is only 35 deg. from the first intermediate crank.

If the two outside pistons can be used as bob-weights for the inside pistons, then conversely the inside pistons may be made to serve as bob-weights for the outside pistons. With the same proportions for the engine Schlick suggests the arrangement shown by Fig. 14. Here the high-pressure and first intermediate cranks are at right angles, while the second intermediate crank is 36 1-2 deg. from the horizontal and the low-pressure crank is 18 1-2 deg. from the vertical. The succession of crank is therefore

High-pressure to second intermediate.....	143 1/2°
Second intermediate to low-pressure.....	145°
Low-pressure to first intermediate.....	161 1/2°

This would appear to give a smoother turning effect than the previous arrangement and to give a better arrangement for starting. But for that matter it appears that a proper arrangement of by-pass valves for supplying steam to the larger cylinders ought to allow the engineer to start with certainty from any position of the engine.

To determine the position of the two outer cranks for the first arrangement shown by Fig. 13, we may proceed as follows: Assume that there are symmetrical disks placed at the positions where the out-

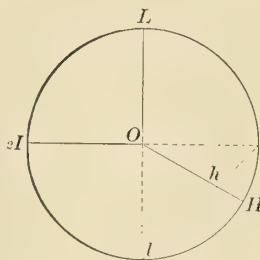


FIG. 15

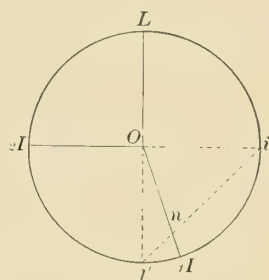


FIG. 16

side cranks (high-pressure and first intermediate) are to come, and find the proper counterweights to be attached to these disks to counterbalance the two inside pistons. Fig. 15 may represent the forward disk and Fig. 16 the after disk; the positions for the second intermediate and low-pressure cranks are marked on the disks for reference. The counterbalance weights for the second intermediate piston will be at *i*, Fig. 15, and at *i'*, Fig. 16, and will be inversely proportional to the distance of the second intermediate cylinder from the high-pressure and first intermediate cylinder, or, what amounts to the same thing, from the assumed counterbalancing disks. The counterweights for the low-pressure piston will be at *l* and *l'*. The sum of the weights at *i* and *i'* must be equal to the weight of the reciprocating parts of the second intermediate cylinder, and the sum of the weights at *l* and *l'* must be equal to that for the low-pressure cylinder. Now, in Fig. 15, find the center of gravity of the weights at *i* and *l* by dividing the line joining those parts inversely proportional to the weights at *l* and *i*. The center of gravity *h* is the place where a weight equal to the sum of the weights at *i* and *l* can be placed to counterbalance both the inside pis-

tons. In like manner join i' and l' , in Fig. 16, and divide the joining line at n inversely proportionally to the weights at i' and l' . Then n is the place where a weight equal to the sum of those at i' and l' can be placed. The high-pressure crank will be at H on the prolongation of a line drawn from the center of the shaft through h . To find the proper weight of the high-pressure reciprocating parts multiply the counterbalance weight at h by the length of the line $o h$ and divide by the length of the line $O H$. The first intermediate crank is at $I I$ on the line $O n$ produced, and its weight is found by multiplying the counterbalance weight at n by $O n$ and dividing by the radius of the crank $I I$.

A similar construction and calculation can be made for the arrangement shown by Fig. 14, where the counterbalance disks must be assumed to be at the places where the middle cranks are to come. Then counterweights are determined for the high-pressure and first intermediate reciprocating parts separately and therefrom single counterweights can be found, which will indicate the position of the inside cranks. The determination of the weights of the reciprocating parts for the inside cylinders is then to be determined as were those for the outside cylinders in the preceding statement for the arrangement of Fig. 13.

If the weights determined for those reciprocating parts which are treated as bob-weights cannot conveniently be used, then the counterbalancing will be imperfect to the extent of the difference between the determined weights and the weights that must be used.

Schlick does not appear to take account of the valves and valve gears in his method of counterbalancing engines. Of course there would be no great difficulty in dealing with the valves and gears for those cylinders whose cranks are at 90 deg.; the difficulty comes in trying to deal with the valves and gears for those cylinders whose reciprocating parts are treated as bob-weights. The only way appears to be to first balance the engine without considering the valves and gears and then add the latter and find how much lack of balance may exist. If the balance seems to be too imperfect, there seems to be no way of improving it except by trial, for of course the eccentrics must be in the proper relative position compared with the cranks to give the proper angular advance.

Though Schlick does not mention the application of his process to four-cylinder triple engines like those shown by Fig. 6, it is evident that it may be used to improve the running of such an engine, if not to give complete balance. To give complete balance it will probably be necessary to give unequal weights to the low-pressure pistons. If that cannot be done, the same result can be attempted by changing the weights of the high and intermediate cylinders.

It is interesting to note that the British cruiser *Terrible* had the cranks for a four-cylinder triple-expansion engine arranged as in Fig. 6, and that violent vibrations were found to occur when running at nineteen knots. The engines were tried with several arrangements of the cranks, settling finally on an arrangement which was very similar to that shown by Fig. 13 herewith.

AMERICAN SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

UNITED STATES NAVAL ACADEMY AT ANNAPOLIS—DEPARTMENT OF STEAM ENGINEERING.

A Description of the Great National Educational Institution, with Special Reference to the Course of Instruction of the Recent Engineer Division of Naval Cadets.

BY CHIEF ENGINEER F. J. SCHELL, U. S. N.

The United States Naval Academy was founded in 1845 by the Hon. George Bancroft, Secretary of the Navy, in the administration of President James K. Polk. It was located at Annapolis, Maryland, on the land occupied by Fort Severn, which was given up by the War Department for the purpose. Previous to this the instruction of young naval officers had been carried on in a desultory manner at the Naval Asylum at Philadelphia, and at the Navy Yards at Boston, Norfolk and New York, a few Professors of Mathematics and Languages being detailed for this work. The Academy was formally opened under the title of the Naval School, on October 10, 1845, Commander (afterwards Admiral C. S. N.) Franklin Buchanan being the first Superintendent.

Various reasons led to the selection of Annapolis for the site of the Academy, prominent among which were its nearness to the seat of the national government at Washington, and what was then its excellent harbor, now unfortunately fallen quite into disuse for commercial purposes. Then, in addition, sectional lines had some weight, and as the other national Academy, that for the Army, was located in a northern state, it was only considered fair that the one for the Navy should be south of Mason's and Dixon's line.

The site is a beautiful one. Located in the angle made by the Severn river and the harbor of Annapolis proper, it has a water front on two of its sides about 1,800 yards in extent. The original plot contained about seven acres. This has been added to by reclaiming portions of the shore below low water mark, and by purchase, until at present fifty-three acres are included within the Academy walls. The ground rises gradually from the water to a maximum elevation of about twenty-five feet. The grounds are tastefully laid out, and the walks in the older portions are shaded by fine old walnut and maple trees.

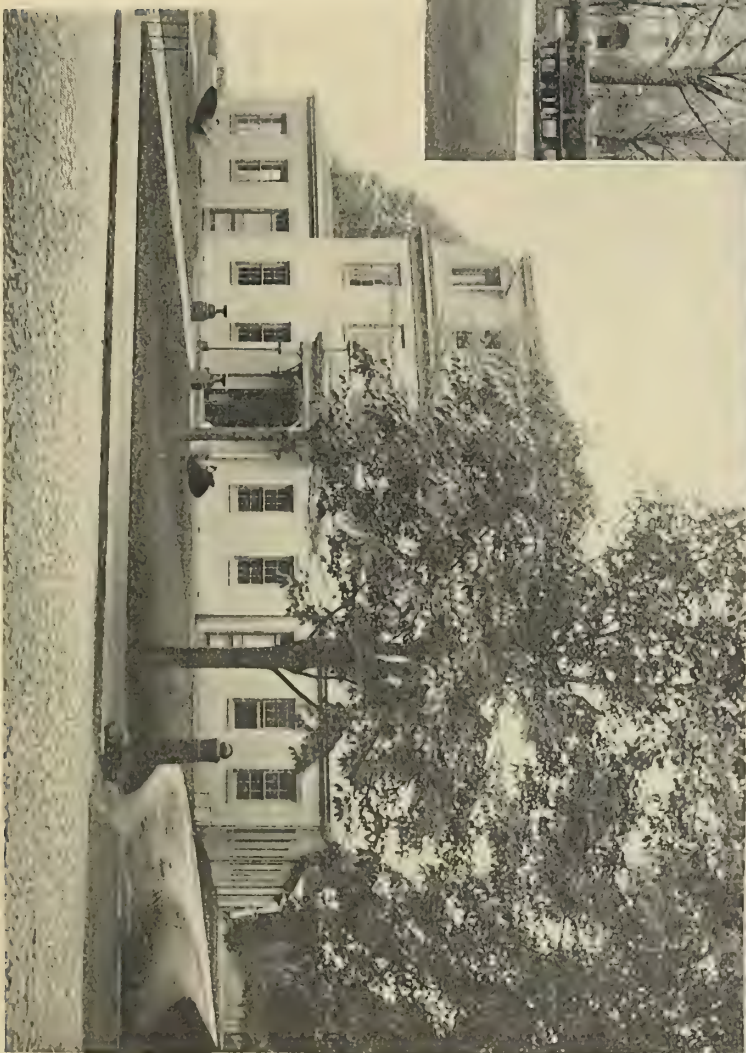
The buildings for officers' and cadets' quarters have been erected at different times to meet the growing needs of the Academy, without following any well defined plan. Some of these, erected hurriedly on made ground, have been found unsafe, so that in 1895 a Board of Naval Officers, after a thorough and exhaustive examination of the subject, decided that the Academy had to be practically rebuilt, and on a scale commensurate with the importance of the Navy as one of the co-ordinate branches of the Nation's defense. An admirable design for rebuilding was worked out, utilizing such of the buildings as could be worked in harmoniously; the total expenditure involved will be some eight to ten millions of dollars. Congress has



Cadet Quarters U. S. Naval Academy.

Boathouse and Ships on Severn River.

Building of Department of Steam Engineering.



EXTERIOR VIEWS AT THE U. S. NAVAL ACADEMY, ANNAPOLIS, MD.

at last consented to deal liberally with the Academy, about one and three-quarter million dollars have been made available, and the first contracts under the rebuilding plan, for a new Armory, Power House and the extension of the sea wall are about to be given out. When the plans are fully carried out the Naval Academy will be second to none in the world in its facilities for imparting instruction, thus insuring for the future the maintenance of the high standard for scholarship, practical knowledge and efficiency that its graduates have always had in the past.

The students at the Naval Academy are styled Naval Cadets, and there are allowed at the Academy one for every Member and Delegate of the House of Representatives, one for the District of Columbia and ten at large. The course is six years. Of these six, four are spent at the Academy and two at sea. At the expiration of the latter the cadets return to the Academy for final graduation, after which they are commissioned in the lowest grades of their corps. As there are thus always two classes at sea, the number at the Academy is always, at least, that many less than the number of Representatives. In addition there are nearly always a few districts in which Representatives have not made appointments, so that the usual number at the commencement of the Academic year, October 1, does not vary much from two hundred and sixty. The last graduating class of fifty-five members had, in addition to the six appointed at large, representatives from twenty-two states. Kentucky headed the list with a representation of five. Ten states had each a single representative.

Candidates for admission are nominated by the Representatives of the different Congressional Districts, and appear for examination on May 15 and September 1 each year. The candidate must be between fifteen and nineteen years of age. He is subjected to a rigid physical examination, and a mental one which the youth who has had a good high school education should be able to pass without special difficulty. Those who receive 62.5 per cent. of the maximum mark in all branches are considered as having passed satisfactorily, and are appointed Naval Cadets by the Navy Department.

The life of the cadet is eminently a busy one, the daily routine being about as follows: Reveille at 6 A. M., when he must turn out, and in the succeeding half hour dress and tidy up his room. Then comes morning roll call, followed by breakfast from 6:45 o'clock to 7:30 o'clock. At 7:30 A. M. sick call, when those in need of medical attention proceed to Sick Quarters to see the Medical Officer of the day. From 7:55 o'clock to 10 o'clock and 10:10 A. M. to 12:15 P. M. are the first and second study and recitation periods. At 12:30 o'clock dinner, for which one hour is allowed. Afternoon recitations are from 1:55 o'clock to 3:55 o'clock, at which latter time recitations end for the day. From 4:10 P. M. to 5:45 P. M. is the drill period, and it is during this period that the cadet receives his practical instruction in the duties of the enlisted man as well as the officer on board ship. In the evening from 5:45 o'clock to 6:30 o'clock is a recreation period. At the latter hour the cadet has his supper. From 7:30 o'clock to 9:30 o'clock is the period for evening

studies, and at 10 P. M. "taps," when all hands must turn in.

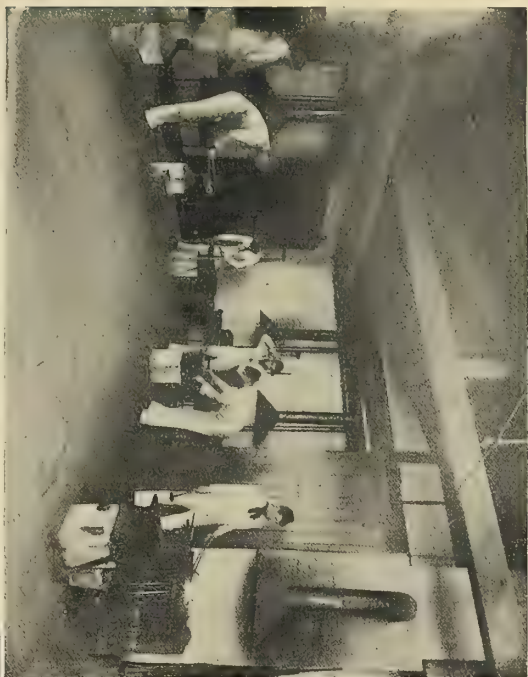
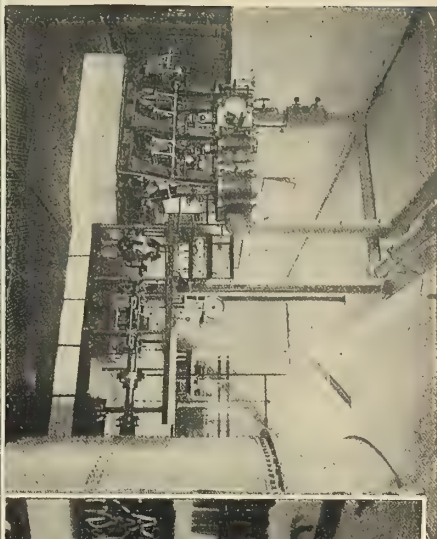
This is practically the routine for five days in the week throughout the Academic year. Saturday morning the first period is for recitations and the second is for drills. Saturday afternoon and evening are free from drills and recitations and are the principal recreation times of the cadet. It is then that he can visit his friends in the city of Annapolis, or the families of officers in the yard. On Saturday evenings the cadet hops are given, lasting from 7:30 o'clock to 10 o'clock. About ten of these are given during the season, and they are largely attended, visitors from as far as Philadelphia or New York being in frequent attendance for the hop. The brilliant function of the year is, of course, the hop given to the graduating class in June, at which at least one thousand guests are expected and welcomed.

Although the cadets' time is well occupied by study, recitations and drills, they still manage to get opportunity for sports and, occasionally, for some of the pranks of their college compatriots. There is always, each in its proper season, a football, baseball and track team and a boat crew in training. Games, which take place on Saturday afternoon, are arranged with different college teams, and the cadets, owing to their pluck and excellent physical condition, are quite uniformly successful. Last year's football team was beaten once, and then by Princeton University. That the cadets indulge in pranks, the illustration of the "Burial of Math." (which takes place when the course in mathematics is finally ended at the end of the first term in the first class year) will show.

The cadets are divided into classes as follows: Those in their first year constitute the fourth class; second year, third class; third year, second class, and fourth year, first class. Class lines are closely drawn; certain seats and walks in the grounds belong to certain classes, and unhappy the lot of the lower classman found occupying either by the "rightful" owners.

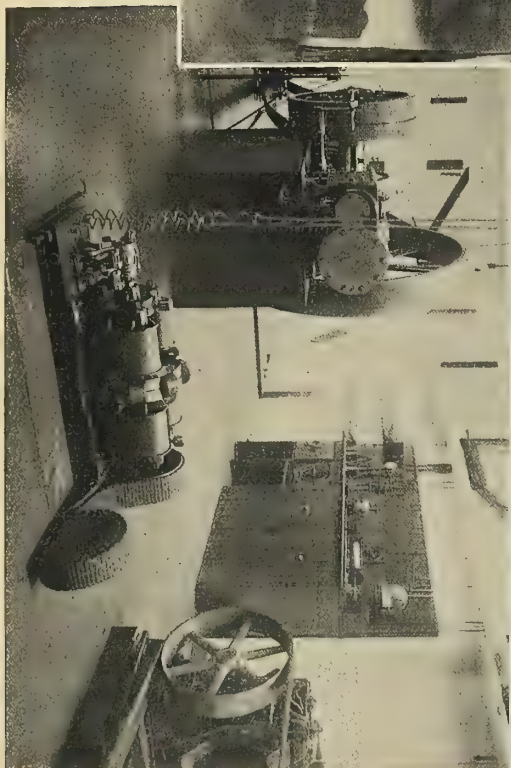
The drills and practical exercises are of many and various kinds, and during the first three years are the same for all cadets. They are drilled as a Battalion of Infantry and of Artillery; are exercised in boats under oars and sails, and have the practical handling of steam launches; have fencing, swimming, boxing, gymnastics, dancing, and cane and broad sword exercises, and also target practice, both with small arms and great guns. The view here printed of the battalion scaling the wall is one of the features of infantry drill. These drills and exercises, many of which take place in the open air, in addition to imparting a vast amount of practical instruction, are an excellent thing for the physical well being of the cadets, "hard as nails" being not at all a misnomer for their physical condition.

The Superintendent is a line officer of the Navy, not below the rank of Commander. Heads of departments and instructors are, with a few exceptions, naval officers, detailed by the Navy Department at the request of the Superintendent, who thus spend their three years' tour of shore duty in instructing in the different Academic Departments. The head of the Departments of Steam Engineering and Drawing is a Chief En-



Experimental Steam Engine.

Blacksmith's Shop—Dept. Steam Engineering.



Pattern Shop—Dept. Steam Engineering.

Dynamo Room and Testing Apparatus.

INTERIOR VIEWS OF WORKSHOPS AT THE U. S. NAVAL ACADEMY.

gineer with the rank of Commander. He has for his assistants one Chief and five Passed Assistant Engineers, and a professor of Drawing, to carry on the work of instruction in the two departments.

By an Act of Congress, approved July 4, 1864, authority was given to the Secretary of the Navy to establish a course of instruction for cadet engineers at the Naval Academy, the number undergoing instruction at any one time not to exceed fifty. It was not until two years later, in 1866, that any appointments were made, when two young men were admitted. With these, and two admitted the following year, the cadet engineer system at the Naval Academy had its beginning. Of the four so admitted, one remains in the service to-day, and is Chief Engineer of the Naval Station at Havana.

In 1866, a class of sixteen Acting Third Assistant Engineers was ordered to the Naval Academy to pursue a two years' course of instruction, and these were graduated in 1868.

The education of engineer officers at the Naval Academy met with considerable opposition, and it was not until 1871 that the system of admitting each year a number of cadets to study engineering subjects to fit themselves for the duties of engineer officers in the navy can be considered as having been regularly established. In that year a class numbering sixteen was admitted, the appointments being made after competitive examination. This class, and the classes admitted in 1872 and 1873, pursued a course lasting two years, and were then graduated. After performing from one to two years' sea service in cruising naval vessels the members were commissioned as Assistant Engineers.

In 1874, the course at the Academy was extended by Congress to four years, this applying to the class entering in September of that year; this was the first *fourth* class of cadet engineers to become a part of the battalion of midshipmen, as it was then called. The appointments were made after competitive examination, the subjects of examination stated in the circular being the following: "Arithmetic, Algebra through equations of the first degree, Plane Geometry, Rudimentary Natural Philosophy, Reading, Writing, Spelling, English Grammar, English Composition, Geography, Freehand Drawing and an elementary knowledge of the principles governing the action of the steam engine." It was also specified that "other qualifications being equal, those possessing the greatest skill and experience in the practical knowledge of machinery will have precedence for admission."

The cadet engineer system being now well established, candidates in increasing numbers appeared each year, until finally there were as many as two hundred and fifty competitors for the twenty-five appointments. The examination, although apparently easy from a superficial view, was, in fact, made by the Academic Board sufficiently searching on the subjects specified. In fact, this system of selection was such as to insure that the young men selected were the scholars. Classes of twenty-five were admitted each year, the course was well worked out and improved, until with the fine material at its disposal, it became at the time when it was abolished, a school of marine engineering

not excelled by any. The Act of Congress of August 5, 1882, making extensive reductions in the navy, swept the marine engineering course out of existence. To show that the school had been successful in the results sought to be obtained, it is only necessary to refer to the prominent part taken by its graduates in the designing, building and management of the machinery of our new naval vessels; or to the high positions taken in the engineering world by those who, wearied by their long wait for promotion, have resigned.

The present course was established by special act approved March 2, 1889, in which it is provided: "That the Academic Board of the Naval Academy shall on or before the thirtieth day of September in each year, separate the first class of naval cadets then commencing their fourth year into two divisions, as they may have shown special aptitude for the duties of the respective corps, . . . and the cadets so assigned to the engineer corps division, of the first class, shall thereafter pursue a separate course of study arranged to fit them for service in the engineer corps of the navy."

It is seen from the provisions of the preceding act that for three years all cadets being educated at the Academy pursue precisely the same course of study, and that it is only during the last year that any separation is made. It might be supposed that, consequently, engineering education was limited to this one year's course of instruction; such, however, is far from being the case, as, in fact, instruction in engineering, or its kindred subjects, extends throughout three years of the course.

A short digression here as to the division of time is pertinent.

The Academic year, extending from October to June, is divided into two terms of four academic months each. The day is divided into three study periods of two hours each, one hour of the two being devoted to study, and the other to recitation in the different branches, so that there are in one week sixteen (one on Saturday morning) such periods. Following this there is a drill period of one hour and a half, which is devoted to drills and practical work of different kinds.

During the third class year an average of three periods a week of two hours each throughout the year is devoted to mechanical drawing, and during the second class year two periods a week during the first term are thus employed.

When the cadets become second classmen their text book work in steam engineering begins; during the first term three periods each week are given to the study of mechanism—Goodeve's Elements of Mechanism, with accompanying notes and problems, by Passed Engineer Gow, being the text books used. The study of mechanism being completed, the beginning of the second term finds the class commencing the study of Marine Engines, three periods a week being devoted to the subject, and that most excellent work, the Marine Steam Engine, by Sennett and Oram, with notes, problems and additions to conform to United States naval practice, are used as the text books.

At the end of the annual examination in June of each year the assignment to the engineer division



NAVAL CADETS AT WORK IN MECHANICAL DRAWING CLASS AT THE U. S. NAVAL ACADEMY, ANNAPOLIS, MD.

is made, and, after a practice cruise lasting three months, the last year of the course is commenced.

A glance at the material available for assignment will be of interest. The collegiate work preliminary to the professional course has been finished during the preceding three years, and during that time a constant weeding out process has been in operation, so that of the ninety or one hundred who started as fourth classmen about forty-five to fifty will have been left. Those who proceed have their methods of thought and study so well developed that they can grasp and digest an immense amount of matter in a comparatively short time, from twenty to twenty-five octavo pages being the usual lesson in each of the three subjects for the day.

The methods pursued, coupled with the fact that future promotion, as regards classmates, depends on the standing taken at the end of the course, furnish the strongest incentives to doing the maximum of work. The sections assigned to each instructor are small, ten at the most, with the average about eight, and each cadet receives a considerable amount of the instructor's attention. The standing rule in many of the departments is to keep the cadets employed throughout the entire recitation hour. Marks are assigned for each recitation; examinations are held monthly, semi-annually and annually. Daily, weekly and monthly marks are combined in a certain definite manner, and those who do not receive 62.5 per cent of the maximum for their final mark are considered as unsatisfactory and are required to resign. From the preceding it is seen that the material from which the first class is formed is well and thoroughly sifted.

The assignment of time in the first class year gives ten periods a week to steam engineering, three to mechanics and strength of materials, and three to electricity, light and heat during the first term. The second term's assignment is eleven periods to steam engineering and four to naval construction and ship-building; the remaining periods are devoted to hygiene and naval law.

The time assigned to steam engineering is divided among the following branches: Marine engines, boilers, designing machinery and experimental engineering, and in each branch, although text books are used, a vast amount of additional matter is given the cadets by means of notes published in pamphlet form, each cadet being provided with a copy.

A statement more in detail of the items in each branch will be necessary for a proper understanding of the course. Some of the items in the branch "Marine Engines" are as follows: Horse power, nominal and indicated, and the efficiency of the engine; resistance of ships and the horse power necessary for speed; space occupied and general description of modern marine machinery; engines, simple, compound and triple-expansion; expansion of steam, mean pressure, etc.; piston speed, stroke of piston, revolutions, size of cylinder; cylinder fittings; the piston, piston rod, connecting rod; shafting, crank, line and propeller shafts; foundations, bed plates, columns, guides and framing; the condenser and its necessary pumps; valves, valve gears and valve diagrams; propellers, sea cocks and valves; erecting machinery on board ship;

starting and reversing of main engines; materials used by the marine engineer.

These are studied, with Seaton's Manual of Marine Engineering as a text book, supplemented by lectures, notes, and oral instruction as is needed to make the cadets thoroughly acquainted with the latest American marine engineering practice.

A short course on metals and alloys is given, using as a text book Metals, by Huntington and McMillan; also a course in Thermodynamics, with Cotterill's Steam Engine as the text book, supplemented by notes, and a short course covering the practical operations of casting and founding, smithing and forging, boiler making and plate work, and laying off machine work is given, using Lineham's Mechanical Engineering, Part I, as the text book.

These courses are all embraced under the head "Marine Engines," to which three periods a week throughout the year are assigned.

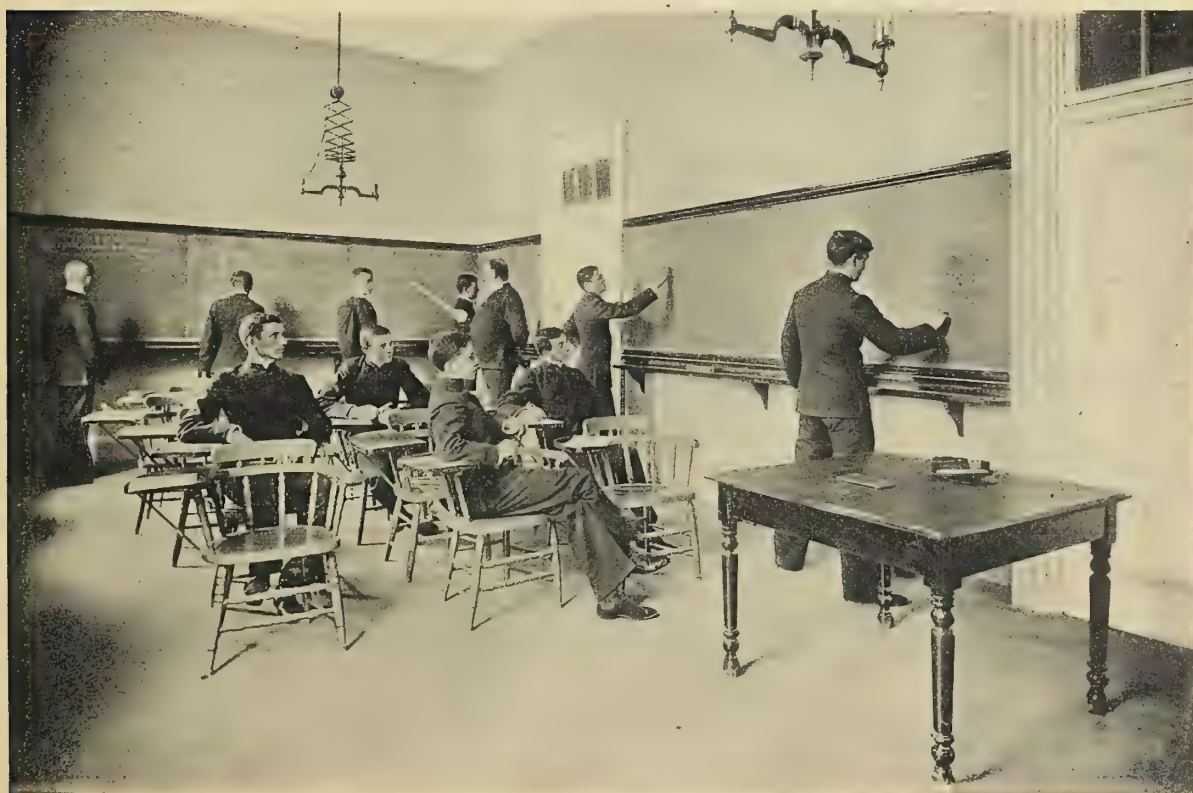
The course in "Boilers" extends throughout the year. The first term is devoted to a practical study of the different types of boilers, both for land and marine purposes, with special attention to the types, both cylindrical and water tubular, specially adapted for use at sea; the different fuels used, boiler mountings and details, the arrangement of different units to obtain the necessary power, the wear and tear, and the methods of making the necessary repairs. The aim being to give the cadet a thorough knowledge of the marine boiler, in its entirety and all its details, as well as a good idea of the proper methods of management to insure economical working and freedom from accident and extensive repairs. Stromeier's Marine Boiler Management and Construction forms the ground work from which this portion of the course is built up, which has two periods a week during the first term devoted to it.

Having become thoroughly familiar with the foregoing, the next step in the course is the practical design of a boiler or set of boilers, and a sample problem is as follows: "Required, a set of boilers to supply steam of 160 lb. pressure to triple-expansion engines, such as are used in a modern naval vessel of the cruiser class; the boilers not to be under an air pressure in excess of one inch of water; the engines to develop 16,000 I. H. P. as an average for four hours. The space available in the ship for boilers, fire rooms, feed pumps, etc., is 102 ft. long, 40 ft. wide, and 20 ft. high."

For working out this problem, a pamphlet, embodying the latest American practice, has been written by instructors at the Academy, and in it all of the calculations necessary for a set of boilers are made in every detail. The cadets also have access to blue prints showing the latest practice of the Bureau of Steam Engineering of the Navy Department, and from the data thus obtainable work out, under the instructor's supervision, the boiler design for the required case, deciding on the type, number and size of boilers, making the necessary provision for easy firing, fixing the sizes and dimensions of all the different parts, including details of all riveted joints. Such a drawing, for instance, shows one of five double-ended boilers, which, with two single-ended boilers of the same diam-



CADETS AT WORK IN DESIGNING ROOM—DEPT. STEAM ENGINEERING.



SECTION ROOM—NAVAL CADETS AT RECITATION.

eter, make up the set. Detail sheets showing the details of riveting, the methods of fitting ordinary and stay tubes, the sizes and shapes of the different shell and combustion chamber sheets, and of other parts requiring special delineation are also gotten out.

In "Designing Machinery" Unwin's Machine Design is used as a text book, supplemented by numerous pamphlets on designing problems, among which may be mentioned notes on design of screw propellers, connecting rods, crank and line shafts, powering ships, condensers and air pumps, and the general design of triple-expansion marine engines complete. In each case a problem embodying one of the above-mentioned subjects has been worked out in detail, showing the method of procedure for the guidance of the cadet. With regard to these pamphlets, it was early appreciated that no set of text books, with reasonable numbers, could be found that would give everything wanted for the course, and the necessity for additional material was apparent from the beginning. The question then arose as to the advisability of teaching by lectures this additional matter. This method was given a trial, but was found to take up a great deal of the cadet's time, both in attending the lectures and writing up the notes afterward; time that, in the opinion of those in charge, could be spent to much better advantage in actual work, so that the system of preparing the lecture material in the shape of pamphlets was tried and found to be thoroughly satisfactory. These pamphlets are reproduced on the mimeograph, and kept up to date by adding each year the necessary additional matter. This, of course, entails a great deal of work on the instructors, but the results show that the labor is well bestowed.

During the year each cadet gets out finished working drawings, tracings, or blue prints of the following: (1) Preliminary sheet to familiarize himself with the use of formulæ, containing the design of a knuckle joint for a boiler brace, a screw jack of certain lift and power, and a connecting-rod end with crank pin brasses, using the strap, gib and key connection. (2) Design of a steel connecting rod, with crank pin and crosshead brasses complete for a high power triple-expansion marine engine. (3) Design of a screw propeller for engines of a given power and to insure a certain required speed for a given ship. (4) General design, elevation and plan of twin screw triple-expansion engines to propel a given ship at a certain required speed. In addition some of the more rapid workers are able to get out designs for the condenser, or construct the necessary valve diagrams, and make detail drawings of the valves and valve gear. In connection with this work the cadets are required to keep note books in which all calculations and data are neatly entered. Five periods the first term and two the second, each, a week, are given to this branch.

The course in "Experimental Engineering" has three study periods a week assigned to it during the second term of four months. Two of these are given to recitations and work in the section room, with Carpenter's Experimental Engineering as a text book, and the third is given to practical work in the engineering laboratory. Following are a few of the numerous tests and experiments that the cadets are required to make,

viz.: Tensile tests and the determination of the elastic limits of the different materials of construction used by the marine engineer; calorimetric measurements of the moisture in steam; friction tests of lubricants, tests of steam pumps, steam boiler tests, analyses of chimney gases, calorimetric tests of the heating power of different fuels, engine tests by Prony brake and transmitting dynamometer, setting steam valves, taking indicator diagrams, standardizing indicator springs, testing steam pressure gauges, calibrating different instruments, use of the slide rule and dynamometric tests of propellers.

There is used for testing purposes a triple-expansion engine of 100 I. H. P., here illustrated, which was built in the machine shop of the Academy by the cadets as part of the course of practical instruction. This engine drives a propeller in a tank and is fitted with indicator motion, transmitting and thrust dynamometers, thus furnishing the means of separating the different elements which go to make up the efficiency of the complete marine engine and propeller in their latest forms.

There is an Allen Dense Air Ice Machine installed in the department, and the cadets run it for a certain period, getting experience in handling the plant that may fall to their care on board ship.

The preceding is a brief outline of what may be called the "theoretical" portion of the course of instruction. In addition there is quite an extended course of practical instruction in steam engineering. This practical instruction begins during the third class year, and continues at intervals until the end of the course. In the last year the drill period, one and a half hours each day, are devoted to it. The cadets have practical instruction, and are required to do actual work in pattern-making, smithing, founding, casting and work in the machine shop, at all machine tools, and undergo a special course with hammer, chisel and file at the vise bench; enough pipe-fitting is also required to familiarize the cadet with all of the different fittings used. In the vise bench work a modification of the "Russian" system has been used with excellent results.

In the machine shop a fixed preliminary course is pursued by each cadet, consisting in executing to drawings, parallel and taper turning, cutting single and double threads, right and left handed, boring, chasing internal threads, finishing and polishing. After completing this preliminary course each cadet works on the component parts of an engine, one or more of which are always in process of construction in the machine shop. A number of vertical compound and triple-expansion engines, some of them indicating 100 horse power, have been built by the cadets and put in use in the naval service.

In the pattern shop, after the necessary preliminary course to familiarize himself with the different tools, the cadet makes a pattern of some piece of machinery, not too complicated. Then, in the foundry, from this pattern, he makes the mould and casts the piece and, should machining be necessary, finishes it in the machine shop.

In the blacksmith shop the practical work embraces welding, iron and steel; making simple forgings, an-

nealing, tempering, case hardening, and bending and quenching tests of metals.

In the boiler shop, riveting, soft and hard patching, caulking and tube expanding are subjects for practical instruction.

rine engineering establishments along our eastern coast. This cruise lasts three months, from June to September, and is most valuable as a means of acquiring information on practical professional subjects. The cadets in charge of an instructor visit the dif-



CADETS AT WORK—"SCALING THE WALL"—INFANTRY DRILL.

In all cases the cadet is required to work from working drawings, and the necessity for accuracy as to detail of finished work is thoroughly impressed.

Under the head of practical instruction comes the practice cruise, during which the cadets are embarked

ferent shops, and see the processes of construction of the component parts of modern marine engines and boilers, their incorporation into the whole, and the different stages of the erection of the machinery on board ship. They also see shipbuilding processes carried



CADETS AT PLAY—FUNERAL ORATION, "BURIAL OF MATH."

on board a modern naval vessel and visit all of the Navy Yards and the principal shipbuilding and ma-

out, and are thus the better enabled to pursue their course in Naval Construction during the final year.

Occasion is taken to visit and inspect steel making plants near the coast, such as the work at Sparrow's Point, or the Bethlehem Works, at South Bethlehem. Establishments engaged in any novel work of special interest to the marine engineer, such as the manufacture of corrugated furnace flues, are sure to be visited when within available distance of the coast.

That the cadets see understandingly is insured by the requirement to keep a journal in which full descriptions of everything that is of interest must be written up. Sketch books, in which to illustrate novel parts of machinery, or special manufacturing processes by means of drawings, are also required. These journals and sketch books are carefully inspected by the instructor, and any errors that may have been made are noted for correction by the cadet.

The practice cruise is also used as a means of instruction in the duties which the cadets will have to perform on board ship after graduation, both at sea and in port. While the practice steamer is making passage from port to port they stand regular watch with the engineer division, and so perform the different duties which fall to the enlisted force of the engineer department of the cruising naval vessel. They do a certain amount of firing, stand watch as water-tender, oiler, and machinist-in-charge. This gives them a valuable amount of experience in the management of boilers, main and auxiliary engines while under way, as well as in getting up steam and coming to anchor.

Apropos of this practical instruction is an incident of the memorable cruise of the battleship Oregon from the Pacific to our eastern coast (a cruise unparalleled in naval annals, and which reached its climax in the running fight off Santiago, when the fifteen-knot battleship overhauled the twenty-knot Italian built cruiser), related to the writer by Chief Engineer Milligan, U. S. N. He spoke of the enthusiasm of all in his department, and of the hearty co-operation alike of officers and men; how the firemen just off watch would again hasten below at any and every call for increased speed. Mentioning one of his Assistants, who, while at the Academy was one of the best football players, and so blessed with an excellent physique, he said: "You remember R—— of course. Several times when he was on watch we were trying to make speed, and some of the firemen began to play out. He would then take shovel, hoe and slice bar, and work the fires himself, and by his encouraging example nerve the men to renewed efforts." Although the ability to do firemen's duties may not be an essential part of the naval engineer's professional attainments, the ability to do one or many of the numerous jobs on board ship requiring mechanical or trained skill is of decided advantage, and the constant aim of the instruction at the Naval Academy is to have, with reasonable limitations, the trained hand accompany the educated brain.

After four years of study at the Naval Academy the cadets are graduated and sent to sea in cruising ships of the navy for a period of two years. During this cruise, which by law is a part of the course, they obtain the necessary practical experience in the management and care of the machinery to fit them for

their future duties as Assistant Engineers in the navy. Owing to the small number in the grade of Assistant Engineer the graduate cadets have been, within a short time after graduation, called on to perform the regular duties usually assigned to Assistant Engineers. The efficient manner in which they have performed all of these duties speaks well for the course of preparation at the Naval Academy.

The scope of this article allows only a mere outline of the course in the other Academic Departments, which include—*Mathematics*: Algebra, Geometry, Descriptive Geometry, Trigonometry, Plane and Spherical; Analytical Geometry, Stereographic Projections and Solutions of the Astronomical Triangle. *English*: English Grammar, Outline History of the World, History of the United States and of the United

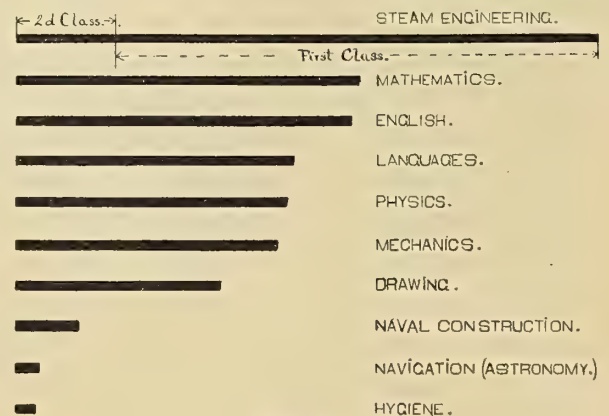


FIG. A.

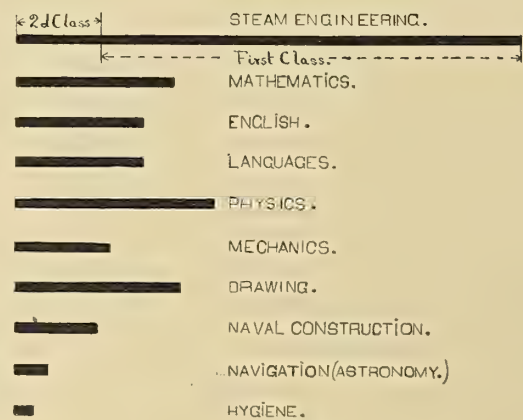


FIG. B.

States Navy, Rhetoric, Composition, the Constitution of the United States, and International and Military and Naval Law. *Languages*: French and Spanish. *Physics*: Elementary Physics, Chemistry and Qualitative Analysis, Light and Heat, Electricity and Magnetism, Physical and Electrical Measurements. *Mechanics*: Differential Calculus, Integral Calculus, Mechanics, Applied Mechanics, Method of Least Squares. *Drawing*: Mechanical and Descriptive Geometry Drawing, Sketching from Models, Making Tracings and Blue Prints. In the Department of Physics, the course in *Electricity* is given, which contains a large amount of practical work, including the running, testing, and management of dynamos.

That the educational standard maintained throughout is a high one is shown by the high rank taken by those graduates who, having been detailed for study abroad, have taken courses in Naval Architecture and Engineering at the best schools of Great Britain and France, where, although thrown into competition with men of greater age, they have either led their classes or stood well up towards the top. The accompanying diagrams, figures *A* and *B*, show, relatively for the entire course, (*A*) the time devoted to recitation in the different departments, and (*B*) the weights given to the multiples for determining the final standing of the different cadets at graduation.

From present indications, before this article appears in print, the Navy Personnel Bill will be enacted into law, the engineer division of cadets at the Naval Academy will be a thing of the past, and in future all cadets will have the same course in engineering. What the course for the "fighting engineer" of the future is to be has not been, perhaps, entirely thought out, but that it may be a development on the lines of the present one to meet the new requirements of the naval service is most certainly to be desired.

Torpedo-Boat Destroyer Ventilators.

Our engraving shows the method of making torpedo-boat ventilators adopted at the Maryland Steel Company's yard at Sparrow's Point, Md. These ventilators are made of copper, and when finished are 4 ft. high, 13 in. dia., with elliptical mouth, 22 in. by 29 in., and as they are made from one sheet of copper they have only one brazed seam. To the right of the figure one of the shapes is shown, and on the truck two completed ventilators. The weight and cost of these ventilators are as follows:

Weight of plate for ventilator before cutting.....	57.44 lb.
Weight of plate after corners are cut.....	50.90 lb.

COST OF FIRST DOZEN.

57 1-2 lb. copper at 16c.....	\$ 9.20
Labor for one ventilator.....	18.50
Complete	\$27.70 each

COST OF SECOND DOZEN.

Copper at 16c. per lb.....	\$ 9.20
Labor for one ventilator.....	14.66
Complete	\$23.86 each



VENTILATORS MADE IN ONE PIECE—BEFORE AND AFTER.

The American-Hawaiian Steam Navigation Co. has been incorporated under the laws of New Jersey, with an authorized capital stock of \$750,000, for the declared purpose of operating a line of steamships between the United States and the Hawaiian Islands. The incorporators include G. S. Dearborn, W. B. Flint and James H. Post, of New York, and O. T. Sewall, of San Francisco, Cal.

By making a ventilator out of one sheet instead of two a saving of metal of 9.33 lb. is effected, which represents about \$1.50, and the labor saved is about \$3.00, or a total of \$4.50 for each. The ventilator is made out of No. 16 B. W. G. sheet. Those illustrated are part of the coppersmith's order at this yard for the U. S. torpedo-boat destroyers *Truxtun*, *Whipple* and *Worden*, now building by the Maryland Steel Company.

TORPEDO BOAT DESTROYERS FOR SEA SERVICE, WITH SPECIAL REFERENCE TO PACIFIC COAST CONDITIONS.*

BY G. W. DICKIE.

Important naval events are occurring in such rapid succession, modifying opinions that we had maintained as perfectly sound, and forcing others to be abandoned that we had considered as firmly established, that any attempt to produce a paper on the subject I have been requested to write upon may fail to express the opinions of the author when it comes to be presented before the Society. In fact, this is the third attempt (begun on the first of August) to put in presentable shape the conclusions arrived at in regard to the chief characteristics required in a design of a torpedo boat destroyer that would meet all the conditions of service on the Pacific coast.

On the first page of a paper that I have just laid aside as not expressing the opinions I now hold, I find the following, that expresses the difficulty of presenting this subject:

"I feel at the present date (April 25, 1898) that I am running some risk of losing any little reputation that I may now possess by the expression of opinions that the stern facts of actual service in war may prove to be entirely wrong. Still, I desire, if possible, to complete this paper before anything happens that would in any way modify the opinions I now hold in regard to the utility of the latest developments in the construction of the type of vessel known as the torpedo boat destroyer."

More events have taken place since the above was written than usually occur in three months of naval history. In fact, these three months have provided material enough for naval architects, marine engineers and ordnance experts to form opinions from for years to come. It takes time, however, to form opinions, and more time to give them anything like practical form, and still more time to test the material forms into which these opinions finally shape themselves. The opinions expressed in this paper have not been entirely formed from the naval events of the past three months, although some of them have been modified by these events.

The conditions of service are not altogether those that war produce. A seaworthy vessel must possess many and varied qualities apart from those belonging to the special service in which the vessel is engaged. A vessel built with the special object in view of carrying large cargoes at a low rate of speed and a low rate of freight must have, besides the capacity to carry, the ability to safely meet the storm conditions of the ocean on which she and her cargo are borne. A fast passenger steamship, built with the special object in view of obtaining the greatest possible speed within the paying limits of the service, must still conform to the stern requirements that the ocean imposes on all those who "go down to the sea in ships and do business in the great waters."

A torpedo boat destroyer must possess other quali-

ties than those necessary for the destruction of torpedo boats. In fact, the destroyer must be a seagoing vessel, able to remain at sea with the fleet to which she is attached or to make independent voyages.

The torpedo boat is intended, if the writer understands the purpose for which such craft are designed, as a part of harbor or coast defence, to be kept under shelter until a chance occurs for her to dart out, under cover of night or fog, and attempt to sink a hostile vessel or vessels. Her work is, therefore, short and sharp, requiring a supreme effort, well directed and of short duration.

The work of the torpedo boat destroyer is to prevent the torpedo boat attack, and is, therefore, performed in open water. She must keep the sea with the attacking fleet, watching every place of refuge for a torpedo boat. She must, therefore, possess speed equal to that of the torpedo boat; a battery powerful enough to destroy her; seagoing qualities to enable her to keep a watch in spite of weather. She should be able to cover long distances at a high rate of speed and in stormy weather. The fleet to which she is attached should not be delayed and hampered by guarding her from harm; she ought, instead, to be able in all kinds of weather to act as a scout in advance of the fleet, keeping the larger vessels informed as to the whereabouts of a possible enemy. Such would be an ideal torpedo boat destroyer.

It cannot be said that the present type of torpedo boat destroyer comes near meeting these requirements. Quite a large number of destroyers now meet the requirements, in the matter of speed, if required for a short time only, in smooth water, and if she is in good order; but the one quality of speed has been made paramount to all other qualities to such an extent that the full speed can only be reached when the conditions are such that the seagoing qualities can be neglected.

It is because we think that the most important qualities required in a seagoing vessel are deliberately neglected in the fastest torpedo boat destroyers, and which we feel renders such vessels entirely unfitted for service on the Pacific coast, that we have mustered courage enough to state, as plainly as we can in words, the deliberate opinions we have formed on this subject.

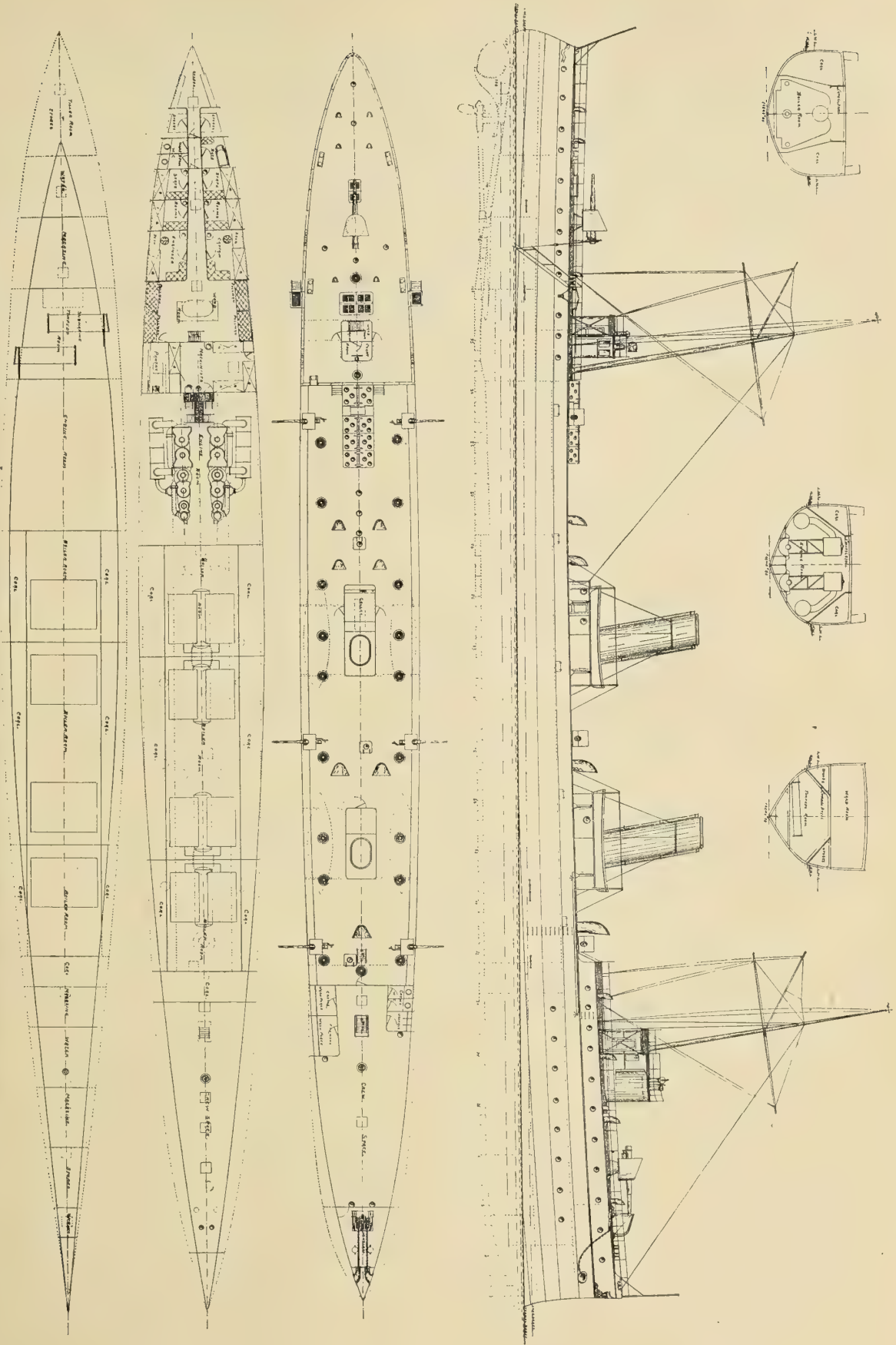
While the conditions of service for such a vessel on the Pacific coast are not different in kind from those that prevail on the Atlantic seaboard of this country, the adverse conditions are far greater on the Pacific.

The great distance between harbors on the Pacific coast and the almost universal condition, of rough water along the coast from Point Conception in the south to Cape Flattery on the north, with only one place of refuge, renders it necessary that any vessel for practical service outside the harbor of San Francisco or the smooth water of Puget Sound must have good seagoing qualities and be able to remain outside in all conditions of weather.

The qualities necessary for this service are not possessed in any degree by the present type of torpedo boat destroyer. While they have made voyages of considerable length at sea, they have done so usually

* Read at the Sixth General Meeting of the Society of Naval Architects and Marine Engineers. For discussion see December, 1898, issue of Marine Engineering,

SKETCHES OF PROPOSED 800-TON TORPEDO-BOAT DESTROYER, MADE BY G. W. DICKIE, SAN FRANCISCO, CAL.



under the care of a larger vessel. They have needed extra care, both in watching the weather, taking advantage of every shelter that lies in the way, and if the destination is reached without mishap, it is something to be proud of, as being entirely outside of the service for which the vessel is fitted.

Now, such a vessel in commission on the Pacific coast cannot go from San Francisco harbor to any other harbor without making an ocean voyage of several hundred miles, with a probability of encountering rough weather.

The disastrous results of many late attempts to steam or tow light craft to Alaskan waters, most of them better able to stand rough water than the fastest type of torpedo boat destroyers, show the necessity of substantial seagoing vessels for service on this coast.

The 420-ton destroyers lately ordered by our Government are a decided improvement in this class of vessel, but we do not think they are fitted even yet to meet the special conditions of service on the Pacific.

The annexation of the Hawaiian Islands requires a much greater radius of action for such a vessel, and, we think, a different treatment. In fact, we maintain that if thirty knots or over is aimed at as the supreme speed, a sufficiently staunch seagoing vessel cannot be produced in the present state of the art, and that the present so-called thirty-knot torpedo boat destroyers have not, in fact, the speed with which they are credited as being available when required.

The supreme efforts required, under expert management and with special trial trip crews, to reach the contract requirements are seldom or never repeated in the life of the boats.

If these boats and their machinery were made more substantial, so that their full power could be exerted at any time and without risk, and the hull stand a moderate sea without danger, the thirty knot boat, by reason of the extra displacement, would drop to about twenty-seven knots; yet we venture to assert that such a boat, ordered to reach a point at sea, say 100 miles distant, in the shortest possible time, would reach the objective point in less time than the regulation thirty knot boat that is said to get a horse power in fifty pounds weight of machinery. A large proportion of naval vessels rated at high speeds, especially those over twenty knots, have obtained such speeds under conditions that cannot be reproduced when the speed is most needed, and a good, reliable, heavy engined, sixteen or seventeen knot boat may outstrip them in a fight.

Whatever speed a fighting ship has ought to be produced when ordered from the bridge. An Atlantic liner would not be considered a success if in ordinary weather she could not cross the ocean at very near her trial speed, and if the machinery of a naval ship were as substantially built she could do the same if necessary as long as her coal held out. Merchant ships are now making the longest possible sea voyages with a steady and continuous production of steam greater than that produced per foot of grate in naval vessels in three, four, or six hours forced draught trials that are said to be so destructive to boilers.

In the merchant service machinery is built for full

power as a normal condition. In the Navy full power is only to be resorted to under great necessity, and maintained at a terrible risk, hence the difference.

Returning to the subject proper of this paper, we would propose for a torpedo boat destroyer adapted for service on the Pacific coast the following general characteristics as necessary to meet the conditions of the varied service required, the outline drawings accompanying this paper being illustrations of how we would embody these qualities in a seagoing vessel:

Length on normal water line.....	250 ft.
Extreme width.....	25 ft.
Depth moulded.....	15 ft.
Draught of water on trial.....	8 ft.
Draught of water loaded.....	9 ft. 5 in.
Displacement on trial.....	640 tons.
Total load displacement.....	800 tons.
Indicated horse power on trial.....	7,000 tons.
Speed on trial.....	25 knots.
Radius of action, 12 knots.....	3,200 knots.
Best speed from San Francisco to Honolulu.....	15 knots.
Best speed from San Francisco to Puget Sound Naval Station, or San Diego, good weather.....	20 knots.

The weights provided for are as follows:

Ordnance	36 tons.
Machinery, including water in pipes and boilers, evaporating plant, tools, spare parts, water in water tanks, etc.....	230 tons.
Hull, complete, and fittings.....	300 tons.
Crew and effects, including portable furniture.....	14 tons.
Coal at normal trim.....	60 tons.

Making the normal displacement.....	640 tons.
Coefficient at 8 feet draught.....	.448

With bunkers full of coal there would be 160 tons added, the full coal capacity being 200 tons.

As will be observed by the outboard profile (see page 25), we have designed this vessel to have a full forecabin, extending to the forward fire room, and a half poop extending to the engine room. Between the poop and forecabin a hammock berthing extends the full length.

The 6 pounder guns, of which there are six, would be carried on rail mounts above the hammock berthing. This arrangement would give very good quarters, both for officers and crew.

Casings around the two smoke pipes are carried up high enough to carry the inner ends of the boat skid beams. This enables four boats to be carried, while the casings furnish room for the galleys on deck.

We propose to carry two 4 in. rapid fire guns, one on the forecabin deck and one on the poop. The conning tower is of 1 in. nickel steel.

There is a chart house aft of the conning tower, and a bridge above. There is also an after steering house on the poop. This covers the stairs to the officers' quarters and carries the searchlight above. This light would be controlled from the forward bridge.

The machinists would occupy a space at the forward end of the poop, entering from the landing leading to the engine room, aft of which would be the ward room, and officers' staterooms. The total complement of officers and crew would be seventy-five.

We have, in this vessel, purposely omitted all deck torpedo launching tubes, believing that they should form no part of the armament of a seagoing torpedo boat destroyer; as such a vessel must be prepared to

go into action along with the fleet of which it forms a part, superior speed would enable her to choose the kind of vessel with which she would engage. The deck tubes would, in such a case, if there was any intention to use it, contain a charged torpedo that would, in such an exposed position, be a constant source of dread to those on board. We have, therefore, arranged for two special submerged torpedo tubes in a protected compartment aft of the engine room. Owing to the limited width of the vessel, these tubes would be designed to open on top instead of at the inner end. We believe that there is no mechanical difficulty in designing the discharging tube and the impeller that carries the torpedo clear of the skin of the vessel before release, so as to admit of the torpedo being placed in the tube from the top side.

The sloping sides of the torpedo room would be of 1 in. nickel steel. We have also provided 1 in. nickel steel protection extending the whole length of the engine and boiler compartments, so as to give a moderate amount of protection when the coal bunkers are empty.

We have shown four Thornycroft boilers in our design, and four cylinder, triple expansion engines of 7,000 horse power. We have allowed thirty tons extra weight for the machinery above that allowed for the same horse power in the usual types of torpedo boat destroyer, so as to have a fair margin of safety in all main parts of the engines and boilers.

In this design our aim has been to produce a sea-going torpedo boat destroyer that can go to sea and remain at sea without any special risk, and at sea can maintain a speed of twenty-five knots for a few hours when such speed is required; that can make extended voyages, thus serving the purpose of a scout or dispatch boat, whenever or wherever such service is required; that carries a battery that makes her a torpedo boat destroyer in fact.

This boat would show better speed under regular service conditions than any of the so-called thirty knot torpedo boat destroyers, and for seaworthiness, habitability, or fighting capacity far outranks them.

The latest addition to the British Navy, the first-class battleship *Glory*, was floated from the building dock at Laird's yard, Birkenhead-on-the-Mersey, England, on March 11. The *Glory* is of the *Canopus* class, designed by Sir William H. White, director of naval construction. Her dimensions are: Length, 390 ft.; breadth, 74 ft.; mean draught, about 26 ft. 6 in.; displacement, 12,900 tons; freeboard forward 22 ft. 6 in., aft 19 ft.; indicated horse power, 13,500; speed, about 18 1-2 knots. The *Glory* has stowage for 2,000 tons of coal. The armor is Harveyized steel. There is a protective deck from the lower edge of the armor, covering the machinery, magazines and other vital parts. She is lighted throughout with electricity, and will be equipped with six searchlights. The armament will consist of four 12-in. 46-ton guns, mounted in barbets in pairs and firing a projectile weighing 850 lb., with a powder charge of 148 lb. There are also forty-three rapid-firing guns and four torpedo tubes. She will have triple-expansion engines and Belleville boilers.

S.S. ATLAS—NEW OIL-TANK STEAMER FOR THE STANDARD OIL CO.

In the inset supplement with this issue the plans for the new steel oil-tank S.S. *Atlas* for the Standard Oil Company are given. This vessel, which was constructed recently at the Roach yard in Chester, Pa., is a fine example of the most modern practice in the construction of vessels carrying oil in bulk. She is a single-deck, schooner-rigged, single-screw steamship of the following dimensions: Length, 248 ft.; beam, 40 ft.; and depth, 22 ft. 6 in. Her gross tonnage is 1,942 tons, and net tonnage 1,243 tons, and with full cargo and coal on board she draws about 19 ft. 6 in. of water. She has a capacity for 720,000 gallons of oil, and is designed with large hatches so that, if need be, she can carry package freight. Her bunkers will hold about 500 tons of coal.

As shown by the accompanying photograph of the vessel ready for her trial, she has somewhat the appearance of an American coast liner, with a fore-castle, bridge house amidships, a house aft, and a tall smokestack. She is built of open hearth mild steel to conform throughout to Lloyd's rules for oil-carrying vessels. The *Atlas* is fitted with a cellular double bottom, extending from the forward bulkhead in the bunker to the after bulkhead in the engine space, about 60 ft. amidships, and this is piped and connected so that it can be used to carry fuel oil, and similar provision is made in the forward and after peaks. There are ten transverse and one longitudinal bulkheads, all very strongly braced by vertical and horizontal girder framing to resist the pressure of the oil cargo. The frames are spaced 24 in. throughout. Those fore and aft of the double bottom are bulb angles 5 in. by 3 in. by 8-20 in., in one piece from center keelson to main stringer plate. The frames of bridge and fore-castle enclosures are bulb angles 5 in. by 2 3-4 in. by 7-20 in. attached to main stringer plate by 7-20 in. brackets and angles 3 in. by 3 in. by 7-20 in. In way of the double bottom Z-bar frames are used, 5 in. by 3 1-4 in. by 3 1-4 in. by 8-20 in., attached to margin plates by 8-20 in. brackets, with double angles 3 1-2 in. by 3 1-2 in. by 8-20 in. Angle reverse frames 3 1-2 in. by 3 in. by 8-20 in. are fitted on every floor, all fore and aft, and run from the center keelson to the turn of the bilge in one piece, and double in the engine space and in way of the boiler bearers under the double bottom. The floors are 24 in. by 10-20 in. for three-fifths the length amidships and 9-20 in. and 8-20 in. at the ends, where they increase in depth in the usual manner. They are attached to the center keelson by gussets and double angles. At the ends beyond the cargo spaces they extend across in one piece, and all are bent up at the bilge. The keel is 36 in. by 15-20 in. for three-fourths the length amidships, gradually reduced to 12-20 in. at the extreme ends. It is double butt strapped and double riveted, with the keelson angles joggled over the straps. The center keelson is 60 in. by 9-20 in. through the cargo spaces, and 8-20 in. at the ends, connected to the flat plate keel by continuous angles 4 1-2 in. by 4 1-2 in. by 9-20 in., gradually reduced to 8-20 in. at the ends. There are three side keelsons

on each side of the center keelson, intercostal, of 8-20 in. plate with double angles 5 in. by 3 1-2 in. by 8-20 in. on the upper edge riveted to the reverse frames and doubling clips and bracketed at the bulkheads to compensate for being cut there. The shell plating at the bottom is 10-20 in. for one-half length amidships and gradually reduced to 9-20 in. at the ends; the side plating is the same amidships and 8-20 in. at the ends. The bow plates at the load line are doubled for about 40 ft. aft of the stem, to resist ice pressure in winter. The sheer strake is 12-20 in., reduced to 9-20 in. at the extreme ends. The hold beams, in one tier, are 9 in. by 3 in. by 21 1-2 in. channel section in the oil compartments, and 9 in. by 3 in. by 9-20 in. bulb angles beyond, supported by stanchions. The steel deck plating is 6-20 in. all fore and aft, with edge seams double-riveted and butts treble-riveted. The stem is 9 in. by 2 1-2 in. hammered scrap, and the stern frame is a steel casting 9 in. by 5 in.

The bridge house enclosure amidships is built of steel about 60 ft. long and is 7 ft. 6 in. high. Forward and aft of the cargo tanks at each end there is a pump room, with a trunk passage running to the upper deck, the whole made gas tight. Coal storage is provided for in one cross bunker extending from the double bottom to the main deck, and two side bunkers in the boiler room, as shown in the drawings. The accommodations for Captain and crew are provided in the bridge enclosure and bridge deck house. The Captain's room is located in a steel house on top of the forward bridge deck; the mates' rooms on the starboard side of the bridge house. The Captain's room is finished in stamped iron sheeting insulated from the body of the house with mineral wool. It is ceiled in hardwood and fitted with berth and chest of drawers, large desk, plate mirror and leather couch, and closet. The mates' rooms are similarly fitted, though in plainer style. The pilot house is of steel, finished in hardwood and containing all necessary lockers, chart table, drawers, and all instruments and modern appliances for navigation, including engine telegraphs. In the bridge enclosure the dining room is located on the starboard side forward, is finished in stamped iron sheeting, and has accommodation for ten at table. The crew's mess room on the port side is fitted with tables and stools for twelve. In this enclosure, as shown on the plan, the well-equipped galley is fitted in the forward end with passages on either side. Here also are various toilet rooms and lavatories, sailors' quarters for six, firemen's quarters for the same number, and oilers' quarters for four, fitted with iron berths and enameled washstands. The Chief Engineer's room is on the starboard side at the after end of the bridge, with door opening into the passage opposite a door in the engine trunk, so that he can go to and from the engine room without delay or exposure in bad weather. Adjoining is the room of the first and second engineers, with hardwood finishings and modern berths and toilet fittings. Between the funnel and engine trunk amidships the donkey boiler is located, with coal bin adjacent on the port side. The bridge enclosure also contains ice, refrigerating and store

rooms, and in fact all the living quarters and conveniences are concentrated in it, the officers being on one side and the crew on the other. At the after end of the bridge enclosure the steering engine is fitted in a steel annex, and it can be operated from the deck overhead, where an additional steering wheel is fitted, as well as from the pilot house; the former to be used should the shafting or gear of the latter give way.

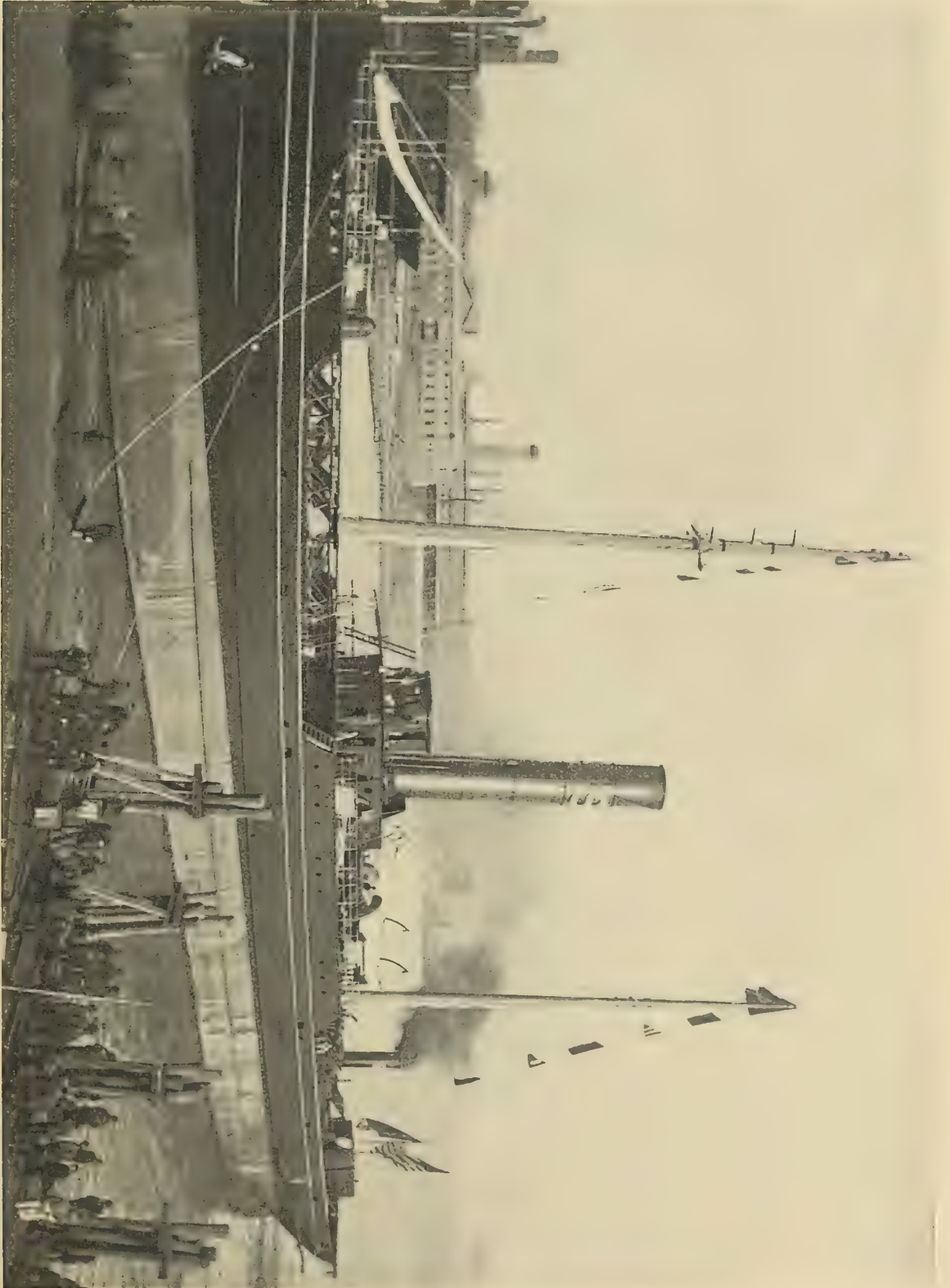
In the forecabin there is a steam windlass fitted for 1 11-16 in. chain, with capstan on top of the deck. Aft there is also a steam capstan, and in the house aft there is a steam towing engine, fitted for 2-in. steel hawser.

The propelling machinery consists of a triple-expansion engine, of about 1,400 I. H. P., with cylinders 21 in., 34 in. and 56 in. dia. and 40 in. stroke of the usual inverted type, with condenser forming part of the back frames. This has a cooling surface of 2,400 sq. ft. The back frames are cast iron, and the front wrought iron, flanged and turned. The crank shaft is built up of fluid compressed steel, and is 11 in. dia. The propeller is four-bladed, of cast iron, and is 11 ft. 6 in. dia. The main boilers are two in number, of the three-furnace single-ended Scotch type, 14 ft. 6 in. dia. and 12 ft. 9 in. long, fitted with Morison suspension furnaces of the interchangeable type, with 160 sq. ft. of grate surface, and built for a working pressure of 170 lb. per square inch. A Bloomsburg circulator with attachment from donkey boiler and feed pipes is fitted to each boiler. The donkey boiler is also of the fire-tube type, 6 ft. 6 in. dia. and 9 ft. long, and built to withstand a working pressure of 170 lb. per square inch. The auxiliaries include an independent vertical air pump, a circulating pump with bilge connections, also a Korting injector, ash ejector, feed pump, sanitary pump, fire pump, evaporator and feed heater.

A very complete piping system connects the various oil-carrying compartments with the pump rooms fore and aft already referred to, and in these rooms powerful duplex pumps are fitted for handling the cargo, with connections to all the oil tanks, sea valves and manifolds. The pumps are of such capacity as to discharge the entire cargo in about six hours. The cargo mains are 10 in. dia., one on each side, running the length of the ship forward and aft. In each oil-carrying compartment there is a 10-in. valve and also two 2 1-2-in. bell-mouth suction connections, with the main fitted with independent valves. The forward pump is connected only with the forward tanks, and the after pump with the after tanks; both are provided with sea suction. The discharge pipes and connections of both pumps are run into one common discharge main, with connections, and are also arranged with the necessary connections for loading. There is also, in addition, an independent loading pipe with valve 6 in. dia. in each compartment, which will be used should the system connected to the pumps get out of order. The valves used are of special make, tested for oil at a pressure of 400 lb. per square inch, and designed especially to withstand the action of naphtha and salt water. All the valve rods run to the upper deck, where bridges and hand wheels are fitted for operating them. Expansion hatches are fitted on

the main deck over each oil tank, about 3 ft. high, which are filled to about half height, allowing the oil

Hoisting engines are fitted at the forward and after cargo hatches. A well space is fitted forward and aft



OIL TANK STEAMER ATLAS, RECENTLY BUILT FOR STANDARD OIL CO. AT ROACH YARD, CHESTER, PA.

to expand or contract with the varying temperature to which it may be exposed during a voyage.

of the machinery space, to separate the same from the oil compartments, and over each well two trunks are

fitted. These are 2 ft. dia. and 1 1-2 ft. high, fitted with cast-iron-hinged covers with rubber joints and clamps. Water tank capacity for 5,000 gallons is provided.

The masts are steel, 28 in. dia. at the foot and 90 ft. above the top of the expansion trunks, and are fitted with cargo booms and all necessary gear. The blocks are of the five-roller pattern made by the Boston & Lockport Block Co. Two bower anchors of the Baldt stockless pattern, each 3,600 lb. weight, are carried; also a stream anchor of 800 lb., and one kedge of 400 lb. The chains include 210 fathoms of 1 11-16 in. stud chain cable, 75 fathoms of 1 1-16 in. close-link stream chain, all tested to Lloyd's requirements. In addition, 200 fathoms of 2-in. steel hawser for towing are supplied. Above the bridge deck in davits three boats are carried. Of these two are metallic life boats and the other a 15-ft. Captain's gig, and there is in addition a life raft in accordance with the U. S. Inspection laws. Side lights are carried on the forecastle in steel towers, and on top of the pilot house a powerful searchlight is fitted. The ship is lighted throughout by electricity, the direct-connected set having a capacity of 150 lights.

The *Atlas* has made two trips to Boston and one to Jacksonville, Fla. Her speed at sea is about 11 1-2 knots, and when towing barge No. 81, containing 900,000 gallons of oil, the speed is about 10 1-4 knots. She is now to take crude oil from Philadelphia to the oil refineries at Tampico, Mexico.

This modern tank steamer was designed by and constructed under the supervision of John Haug, Lloyd's representative in Philadelphia, Pa.

Another long steaming record has been made by the U. S. S. *Oregon*, which arrived out at Manila March 18, after steaming in round numbers 20,000 nautical miles, or a mileage equivalent to four-fifths of the distance round the world. The actual runs made by the *Oregon* on this trip are as follows:

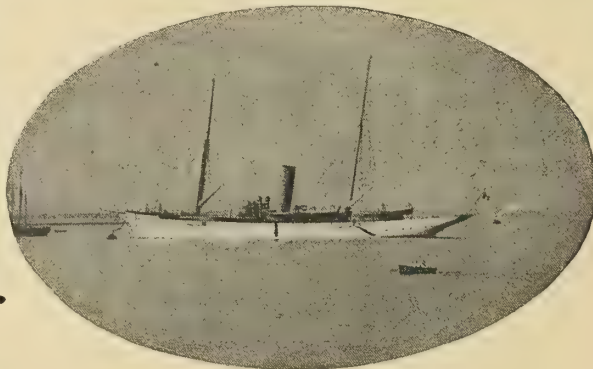
	Naut. Miles.
New York to Bahia.....	4,100
Bahai to Montevideo.....	1,717
Montevideo to Sandy Point.....	1,312
Sandy Point to Valparaiso.....	1,425
Valparaiso to Callao.....	1,309
Callao to Honolulu.....	5,147
Honolulu to Manila.....	5,000
New York to Manila.....	20,010

It is interesting to note that the *Oregon*, classed a coast-line battleship, completed this journey and arrived in fit condition to go straight into action, while the *Iowa*, a battleship with more freeboard, which also started from New York for Manila, was obliged to put into San Francisco for repairs, where she now is. This is the second grand performance of the *Oregon*, the first having been the famous voyage from the Pacific to the Atlantic coast during the Spanish war period, an account of which is published elsewhere in this issue.

A mishap on board the first-class British cruiser *Terrible*, 14,200 tons, was reported last month by cable. An explosion in the stockhold was said to have killed one man and seriously wounded several others. The *Terrible* is fitted with water-tube boilers of the Belleville type.

Sir Thomas Lipton's S. Y. Erin.

A glimpse of the magnificent steel yacht *Erin* now owned by Sir Thomas Lipton, the America's Cup challenger, is shown in the reproduction of a snap shot of the vessel taken recently in Kingstown harbor. This ocean-going vessel was built in 1897 by Scott & Co., of Greenock, Scotland, to the order of a wealthy Italian, Count Ignazio Florio, of Palermo, and originally christened the *Aegusa*. Her dimensions are: Length, 264 ft.; beam, 31 ft. 6 in.; depth, 20 ft. 6 in. Her tonnage is 1,230 tons Thames yacht measurement, and



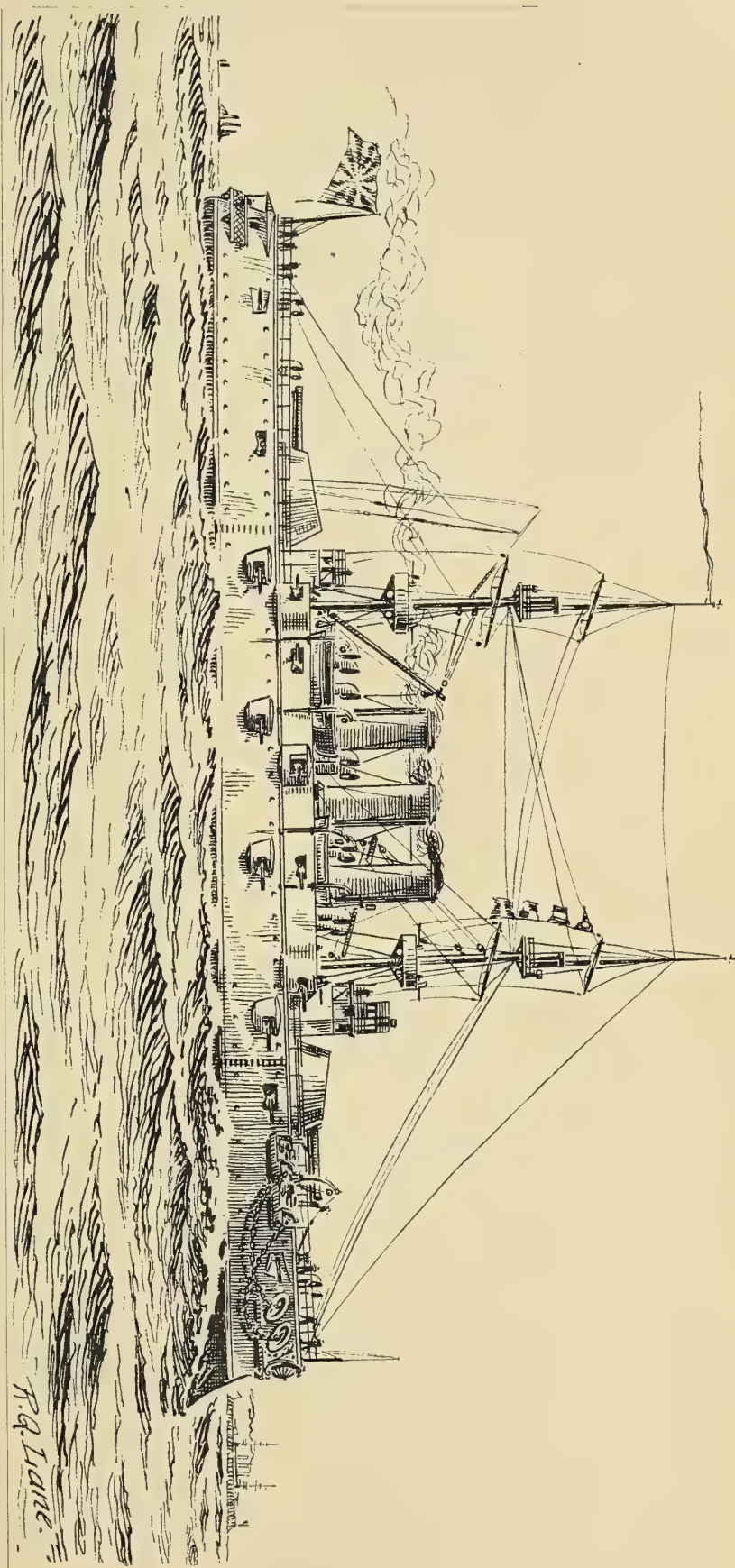
she is fitted with triple-expansion engines of 2,500 horse power and has a sea speed of 16.25 knots. She was purchased recently by Sir Thomas Lipton and renamed the *Erin*. Her present owner intends to take her to New York when he comes over to race the *Shamrock*—now being built by Thornycroft. The *Erin* will be fitted out for this voyage at Cowes. It will be remembered that shortly before the Spanish war, when the U. S. naval representatives in Europe were looking around for war and auxiliary vessels, the *Aegusa* was favorably considered, but for some reasons the negotiations were not completed before war was declared.

According to telegraphic reports, Sir Thomas Lipton will not attempt to sail the *Shamrock* across the Atlantic under her own rig, but will take her across in tow of his S. Y. *Erin*.

As figured out in Congressional Committee, the cost of the war with Spain amounted to \$482,562,083.

Captain Frank Wildes, who was in command of the U. S. S. *Boston* during the fight on May 1 in Manila Bay, has returned home, his three years' service having expired, and he is now stopping in New York. He is the first of the fighting captains of Admiral Dewey's command to reach home.

Under the provisions of the new naval Personnel act an examination will be held, at some date not yet set, to fill the rank of Warrant Machinist in the Navy. There are 100 appointments to be made by competitive examination. The 400 machinists now serving in the Navy will, undoubtedly, first be given the opportunity for promotion; but should a sufficient number not be secured thus, then appointments will be made from civil life. Already a number of applications have been filed at Washington.



JAPANESE FIRST-CLASS BATTLESHIP SHIKISHIMA, UNDER CONSTRUCTION AT THE THAMES IRON WORKS, LONDON.

The pen sketch shows the new Japanese battleship Shikishima, now under completion at the Thames Iron Works, London, as she will appear steaming at sea. This vessel, which may be classed as a coast defense first-class battleship, is of great size and power. Her dimensions are: Length, 400 ft.; beam, 75 ft. 6 in.; draught, 27 ft. 3 in., and she will displace 14,855 tons. Having been designed primarily for service in home waters, her coal-carrying capacity is limited (700 tons), but the weight gained here has been used to advantage in her armor plating and batteries.

She is fitted with triple-expansion engines of 14,500 I. H. P., which are expected to give her a sea speed, with forced draught, of over 18 knots. For protection she has an armor belt the full length of the water line, a belt over her central battery, a protective deck, and armored casemates and barbets. The armament includes four 12-in. guns in the two barbets, fourteen 6-in. rapid fire, twenty 12-pounders, and twelve 47-m.m. rapid fire guns; also five torpedo dischargers. The twin-screw engines have cylinders 34 in., 53 in. and 84 in. dia., and 48 in. stroke. She has

also twenty-five Belleville water-tube boilers, with 1,140 sq. ft. grate surface and 38,000 sq. ft. heating surface, designed for a working pressure of 270 lb. per square inch. The Shikishima will carry a complement of 741, which includes an admiral and thirty-eight officers, accommodation for the latter being provided on the main deck and the crew being berthed in the forward part of the ship, mess accommodation being provided for the whole ship's company at one sitting. She will carry thirteen boats. Similar vessels are now building at Stettin, Elswick and Clydebank.

CONSIDERATION OF THE INDICATOR AND ITS USES ON BOARD SHIP—III.*

BY R. W. JACK.

Referring now to Fig. 9, it will be evident that the mean velocity of piston per degree of the crank arm's movement is equal to the difference of the versed sines of the angles of crank and connecting-rod with the line of centers. The line of centers is taken to mean the line connecting the center of shaft with the center of crosshead. The difference of the mean velocities gives the acceleration or retardation of the motion. To take a simple example, let us suppose that the piston travels at 1 in. during the first second under the action of a uniform force. At the end of the first second it has acquired a velocity of 2 in. per second, i. e., the velocity at the end of any unit of time is equal to twice the mean velocity or distance traveled per such unit. Starting from rest, we thus have an acceleration or difference of velocities at the



FIG. 9.

beginning and end of any interval of time of twice the mean velocity or space fallen through. At the end of the second the piston has acquired a velocity of 4 in. per second, at the end of the third second 6 in. per second, and so on, the velocity increasing directly as the time. The total distances fallen from rest at the end of each second are, respectively, 1 in., 4 in., 9 in., 16 in., etc., varying as the square of the times, and therefore the distances fallen during each consecutive second, which we take as the mean velocities, are 1 in. (4 — 1), (9 — 4), (16 — 9) = 1 in., 3 in., 5 in., 7 in., etc., showing an increase in the mean velocities, or acceleration, equal to 2 in. per second.

It is the same with the piston of an engine controlled by a crank and a connecting-rod, with this difference, that the acceleration and therefore the force required is not constant, but decreases until the piston attains its maximum velocity, that is, until the crank arm forms a right angle with the connecting-rod. This occurs at an angle of 76 deg. with the line of centers when the ratio of crank and connecting-rod is 1 : 4. At this point on the down stroke the resistance of the piston due to the acceleration of the reciprocating weights, imperceptibly changes to a positive force in the opposite direction in consequence of

the retardation by the crank of the maximum velocity. If the connecting-rod were of an infinite length, or if the motion of the piston were communicated by an arrangement such as a slotted donkey crosshead, then the direction of the pressure on the crank pin would always be parallel to the line of motion of the piston, and the velocity of the piston in relation to the uniform velocity of the crank pin would increase from zero at the beginning of the stroke to a maximum at 90 deg., at which instant the velocity of the piston and crank pin are always the same. The velocity of the piston therefore varies as the sine of the angle of crank arm with line of centers. To find the force which in this case would be necessary to impart the initial acceleration to the piston, we will take a simple example, and find the force which would be required with a piston of unit weight (1 lb.), with a crank of unit length (1 ft.), moving at unit speed (1 revolution per minute). The distance that the piston would move from the dead point during the first degree of the crank's revolution is so small that we may suppose its motion to be uniformly accelerated without sensible error. So minute is this distance that it may be most conveniently taken from a table of natural sines, etc., instead of attempting its measurement by the graphic method. It will be found that the versed sine of an angle of 1 deg., when the radius is taken as unity, is .0001523, i. e., the piston has traveled this decimal of a foot during the first degree, and the time occupied at the rate of 1 revolution or 360 deg. per minute is therefore $\frac{1}{360}$ th of 1 minute or 1.6 of 1 second. How does the force under which it moves compare with that which would be imparted to it by gravity, or its own weight? To answer this we must compare the distances fallen in the same time. A body falling freely from rest under the attractive force of the earth alone falls 16 ft. (approximately) during the first second. What distance, then, does it fall during the first one-sixth of a second?

$$1^2 : (\frac{1}{6})^2 :: 16 : x. \therefore x = (16 \times \frac{1}{6} \times \frac{1}{6}) \div 1. = \frac{16}{36} \text{ ft.}$$

The forces vary directly as the distance fallen during the same interval of time,

$$\therefore \frac{f}{g} = \frac{.0001523}{\frac{16}{36}} = .000341 \text{ lb. (approximately),}$$

i. e., the force required to overcome the inertia of piston, etc., weighing 1 lb., when the crank is 1 ft. long and describes 1 revolution per minute, is equal to .000341 lb. We are now enabled to construct a formula which shall embrace the varying conditions of weight, speed and length of crank. Considering only the first degree of the crank's motion, we may conceive it as acting under a uniform force, and it therefore follows that the distance fallen through by the piston varies with the length of the crank and as the square of the time. Since the rotational motion of the crank is also uniform, time may be replaced by its equivalent in revolutions of the crank, and thus, instead of the distance fallen varying as t^2 , we may write it varying as N^2 , because $N \propto t$ when the speed is constant. If, then, F be taken to represent the force required to start the piston, etc. (W), from rest, with a crank L feet in length and making N revolutions per minute, then

$$F = .000341 W L N^2$$

*From a paper read before the Institution of Engineers and Shipbuilders at Hong Kong.

and if A = the area of piston and P = the pressure per square inch, then

$$P = \frac{.000341 W L N^2}{A}$$

Let us now apply this rule in a simple example. Suppose the piston and its appendages weighs 1,000 lb., length of stroke 2 ft., or length of crank 1 ft., making 100 revolutions per minute, and the area of piston being 300 sq. in. What is the pressure per square inch necessary to impart to the piston its initial velocity?

$$P = \frac{.000341 W L N^2}{A} = \frac{.000341 \times 1,000 \times 1 \times 100 \times 100}{300} = 11.36 \text{ lb.}$$

It would therefore become necessary in dealing with an indicator card taken from such an example under the conditions of a connecting-rod of infinite length, to deduct from the initial effective pressure 11.36 lb. in order to represent the pressure transmitted to the crank pin.

To ascertain the modification which this result must undergo in order that it may conform to the practical considerations of a connecting-rod of the usual ratio of crank, we have only to compare the distances that the piston has moved from rest during the first degree of the crank's motion. It has already been stated that with a crank 1 ft. in length, and with a connecting-rod of infinite length, the distance moved by the piston is .0001523 ft. With a connecting-rod whose ratio to crank is as 4 : 1, the distance becomes .0001904; when the length of connecting-rod is to crank as 5 : 1, the distance is .0001827. The forces required vary as the distances traveled in the same time, so that under the conditions of a connecting-rod four times the length of crank, instead of 11.36 lb. per square inch, we have, representing the initial force,

$$11.36 \times \frac{.0001904}{.0001523} = 11.36 \times 1\frac{1}{4} = 14.2 \text{ lb. per sq. in.}$$

Now, in order to convert an ordinary indicator diagram from a measure of work to a diagram of stresses on the crank pin, not only the distance traveled from rest by the piston is necessary, but also the relative velocities or accelerations occurring at each interval of the stroke. Stated mathematically, if x be the angle of the crank, y the angle of the connecting-rod, n the number of cranks in the connecting-rod, and d the total distance traveled by the piston from the top end of stroke in the first quadrant (an engine of the marine inverted type being observed throughout) then

$$d = \text{vers } x + (n \text{ vers } y).$$

In the second quadrant or half-stroke of the crank the distance measured from the bottom end is:

$$d_1 = \text{vers } x - (n \text{ vers } y).$$

If those distances be calculated for every degree of the crank's revolution, we are in possession of everything necessary to the object in view. The difference of the distances for each degree will give the mean velocity during that interval and the difference of the mean velocities which takes place within any two consecutive equal intervals is the acceleration acquired. It is to this result we must direct our attention, for remembering that a force varies directly as the accelerations produced, we are in a position to obtain the corresponding forces for any given position of the

crank. The force required to impart the initial velocity to the piston has been found by comparing the distance traversed by the piston during the first degree of the down stroke, with the distance it would fall under a force equal to its own weight. It will be sufficient for our purpose, however, to find four points on the curve, viz., the initial force required at each end of the stroke, that point in the stroke where the piston attains its greatest velocity, and a point on either side. We will therefore take an example from actual practice, and find those points which shall enable us to convert an ordinary indicator card from one of pressures on the piston to one of actual pressures on the crank pin.

The diagram shown in Fig. 10 is taken from an engine, the diameter of whose cylinder is 17 in., length of stroke 2 ft., and the weight of piston, rods, etc., is approximately 1,200 lb., the revolutions being taken at 130 per minute. The ratio of connecting rod to crank

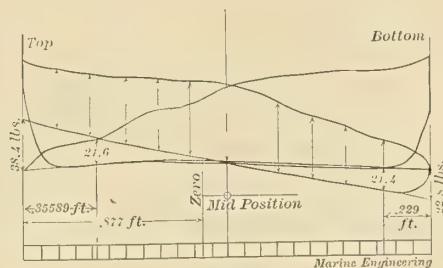


FIG. 10.

is 4:1. To find the first point, that is the initial force required to set the mass in motion from the top end, we will use the formula previously given and modify the result to compensate the error due to the angularity of the connecting rod. Let the symbols be taken as before, then

$$P = \frac{.000341 W L N^2}{A} = \frac{.000341 \times 1200 \times 1 \times 130 \times 130}{17 \times 17 \times .7854} = 30.5 \text{ lb. per square inch.}$$

To estimate the real pressure we must, as before, multiply this result by $\frac{.0001904}{.0001523}$, i. e., approximately 1.14 then, $30.5 \times 1.14 = 38.1$ lb. per square inch to be subtracted from the initial effective pressure on the piston. To find the retarding pressure at the lower extremity of the down stroke, we will again compare the distances traveled by the piston during the last degree of the stroke, and we find that during this interval the piston travels only .0001142, i. e., vers $x - (4 \text{ vers } y)$. If the connecting-rod were of infinite length, then the acceleration would simply depend on the difference of the differences of the versed sine of crank arm with the line of centers, because the angle of the connecting rod would be infinitely small and might be disregarded. Opposite positions of the crank would therefore have the same value, and the acceleration would not only be equal to the retardation, but would correspond at every point equidistant from the dead points or ends of the stroke. We see, then, that the distances traversed by the piston during the last degree toward the dead point on the bottom is with a connecting rod of the usual proportions less than that

which is due to a connecting rod of infinite length. Again, the forces necessary are directly in proportion, thus,

$$.0001523 : .0001142 :: 30.5 : x,$$

therefore the force which is given out on the crank pin by the retardation of the piston is in this case

$$P = 30.5 \times \frac{.0001142}{.0001523} = 30.5 \times .749 = 22.875 \text{ lb. per square inch.}$$

To find that point on the curve at which acceleration of the piston changes to retardation, that is when the piston has attained its greatest velocity, it will be understood that this will also be a point on the back pressure line of the diagram since it affects neither acceleration nor retardation. This point is therefore at a distance from the beginning of the stroke corresponding with the position of the piston when the connecting rod makes a tangent to the crank pin circle. Fig. 11 represents the actual positions—*E F* is the

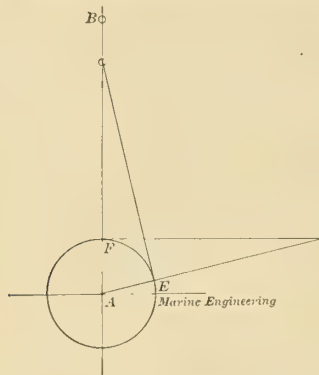


FIG. 11.

crank pin circle, *AB* is the total distance from center of shaft to center of crosshead (equal to length of crank *AF* + length of connecting rod *FB*). Then the angle *AEC* being a right angle,

$AC^2 = EC^2 + AE^2 \therefore AC = \sqrt{EC^2 + AE^2}$, in the present case—

$$AC = \sqrt{4^2 + 1^2} \sqrt{17} = 4.123.$$

The distance *CB* is therefore equal to (*AF* + *FB*) — *AC* = (1 + 4) — 4.123 = .877 ft. or 10.524 in., i. e., the piston is (12 — 10.524) 1.476 in. from the center of its stroke, and this becomes another point on the inertia curve of the diagram.

The Oceanic Steamship Co. is reported to be negotiating with the Cramps for the construction of two 6,000-ton 17-knot steamships to be added to their trans-Pacific fleet.

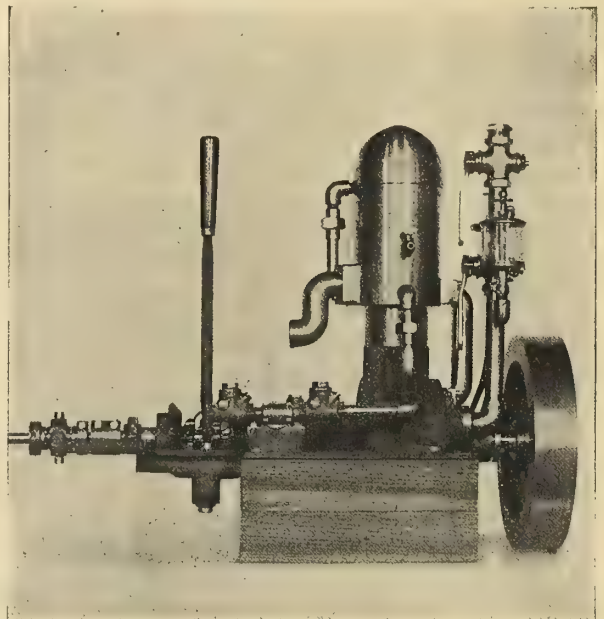
As showing the severity of weather on the Atlantic this year, a recent trip of the Cunarder *Lucania* may be cited. She ran just 121 knots in twenty-four hours on a westward trip in February, which lasted altogether eight days.

The auxiliary gunboat Gloucester, formerly the S. Y. *Corsair*, which was chiefly responsible for the destruction of the Spanish destroyers *Furor* and *Terror* at Santiago, is now in service at the Naval Academy for target practice drills.

IMPROVED APPARATUS.

Yale Marine Gas Engine.

Our illustration shows a Yale improved two-cycle marine gas engine which, the makers assert, contains many points of superiority over engines previously built on this system. The design is neat and simple and complete: the bed-plate is light, though very strong, and it carries the reversing gear, universal joint and ball-bearing thrust collars. The latter are arranged to bear on gimbal rings, so that any slight change in the alignment of the engine or stern bearing is compensated for without cramping the shaft, a point of real importance. The circulating water overflows into the exhaust, and, in connection with an improved muffler, eliminates the objectionable features of noise and smell. The fuel tank, in all cases, is put low down in the boat, and a circulating pump is arranged to keep a constant supply in a receptacle located between the two controlling valves shown on the stand-pipe. The air is drawn into the base through a patent rotary valve which opens and closes the suction and transfer ports with absolute certainty and no back pressure. The fuel is forced up from this receptacle by atmospheric pressure and instantly flashed into gas at each stroke of the piston. Under this system it is impossible to flood the engine. When kerosene oil is used (which can be readily done), substantially the same system is adopted, except that the fuel is drawn through a special vaporizer. By feeding a proper amount of lubricating oil in with the air supply, all difficulties of lubrication of the crank and bearings are overcome. In the two-cycle engine a power



YALE MARINE GAS ENGINE.

impulse is secured at every complete revolution of the engine. The charge is first drawn into the base and there slightly compressed, then it is transferred to the top of the cylinder, where it is further compressed on the following up-stroke, a new charge being drawn

into the base of the engine at the same time. At the height of the compression, as the piston goes over the top center, a spark is produced by suitable batteries and coils igniting the charge and causing the resultant expansion from which the power is derived. This system presents advantages for marine work; the explosions are somewhat lighter than in the four-cycle engine, and there being double as many for a single cylinder less vibration is occasioned, thus permitting a lighter fly wheel and the running of a single-cylinder engine at low speeds. As the throws of the crank in this engine are balanced, the makers claim that it is the smoothest-running marine engine of this type on the market. The engines are manufactured by The Denison Electric Engineering Co., New Haven, Conn., in sizes from 1 H. P. to 45 H. P. The company also makes a specialty of direct-coupled outfits for yacht and ship lighting, to use kerosene oil if required.

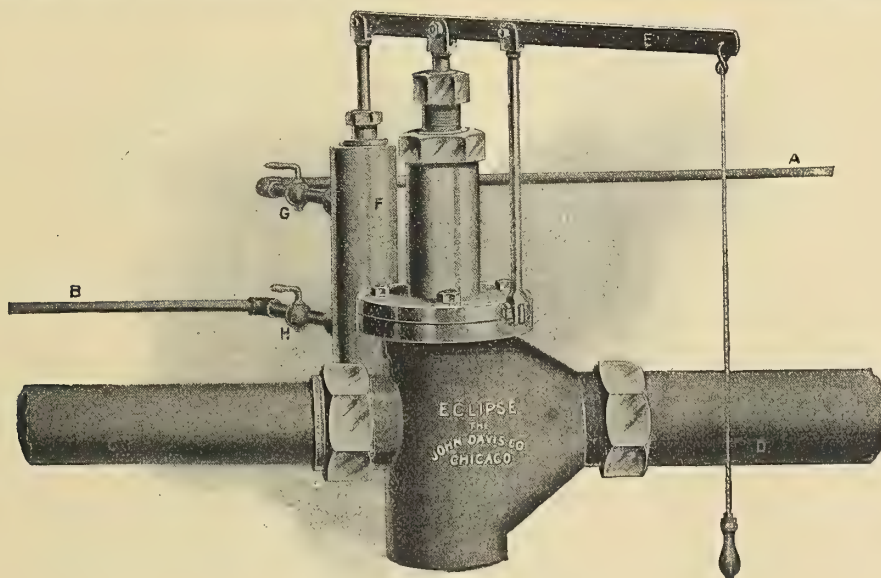
Eclipse Stop Safety Valve.

A broken steam main is a mishap which is, perhaps, more dreaded by the engineering staff of a vessel than any other mishap which might ordinarily occur. To prevent disastrous results from an accident of this sort the Eclipse Stop and Safety Valve has been designed. It is intended to automatically shut off the steam in case of any break in the main or branches. The valve is placed on the steam line as near the boiler as practicable—the main is indicated by *D* and *C* in the engraving. Connection is made by the small pipe *A* with the steam drum, or dome, or top of the boiler, and the pipe *B* taps the steam main beyond the valve in the direction of the engine. To put the valve into operation it is neces-

of pressure coming from the boiler through pipe *A* over the piston would cause it to descend sharply and so close the valve. When equilibrium was restored in the cylinder *F* the main valve could be opened again by pulling down on lever *E*. This valve is manufactured and kept in stock in sizes ranging from 1 in. to 12 in. by The John Davis Co., 79 Michigan Ave., Chicago, Ill.

Chance Launching Cableway.

The want of some better means of launching surf boats than directly from the sand has been felt for many years, and various apparatus for launching has been brought out, but generally with very poor success in service. The devices are usually too clumsy to be easily moved from place to place, yet not sufficiently stable for location permanently in a good situation, and are frequently as dangerous to handle as the boat itself. The apparatus here shown consists of two towers, a shore tower, placed at about high-water mark, and a sea tower placed at a distance of about 400 ft. off. This distance, of course, may be varied to suit the depth of water and topography of the shore line. Other towers may also extend farther out. There is a steel cable between the towers, passing over sheaves at each end, and at the shore end there is an arrangement consisting of springs and pulleys to take up the jar and stretch of cable. The launching device or the surf-boat carrier is hung on trolley wheels, shown in the drawing, the wheels revolving on axles bearing in suitable boxes. The boat is hoisted to place by pulley blocks, and after having been so hoisted, the ropes of the hoisting blocks are made fast



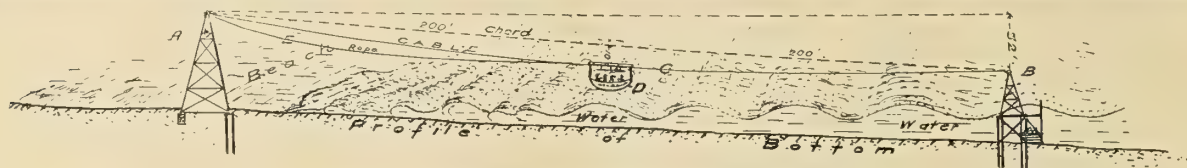
ECLIPSE STOP SAFETY VALVE.

sary to open the cocks *C* and *H* and pull down the lever *E*, until the main valve is wide open. Should a break occur in the main at any point between this valve and the engine the steam pressure under the piston in the cylinder *F* would drop, and the excess

and drop ropes *D*, *D*, attached. These ropes have releasing arrangements so that the boat can be dropped slowly or instantaneously by one man. The hoisting ropes are put away after hoisting on the platform *D*. Pullback rope *E* is for the purpose of pulling back the

carriage after launching. The towers would be made of Bessemer steel throughout, and the cable of the "patent locked wire" pattern, with an ultimate tensile strength of 157 tons. The main tower is planned to

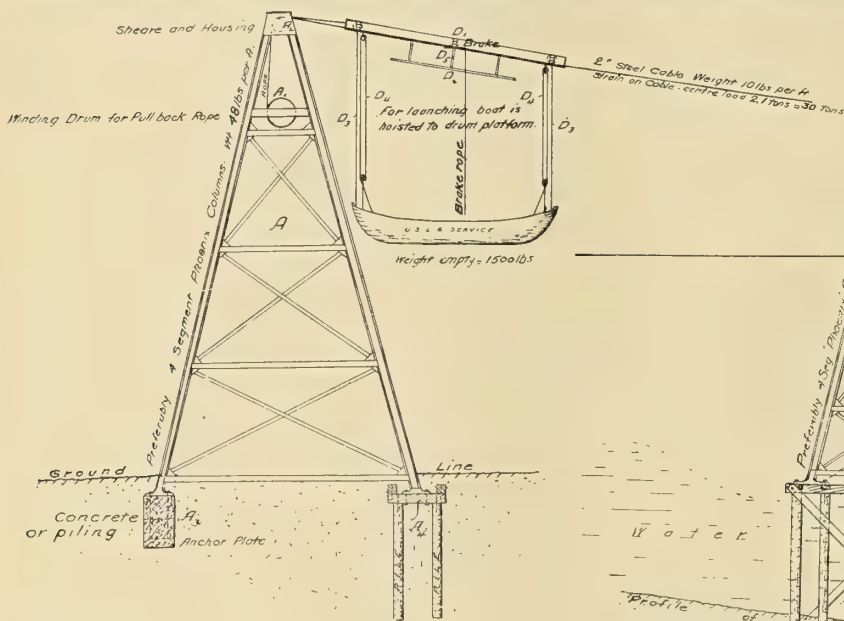
is built on the same general plan as smaller machines manufactured by the company, but has important modifications. The new machine will thread pipe from 1 in. to 4 in. dia. It uses the regular Armstrong



CHANCE LAUNCHING CABLEWAY IN OPERATION.

be 50 ft. high, the sea tower 24 ft. high, the span of cable 400 ft., the drop of rope from one tower to the other 32 ft., the cable 2 in. in diameter. The piling and timbers are 12 in. square. The concrete and rock

stock dies, which are put into the machine and adjusted in the same manner as the hand stock. The dies can be opened after cutting the thread, and when the pipe is removed can be locked back to the stand-



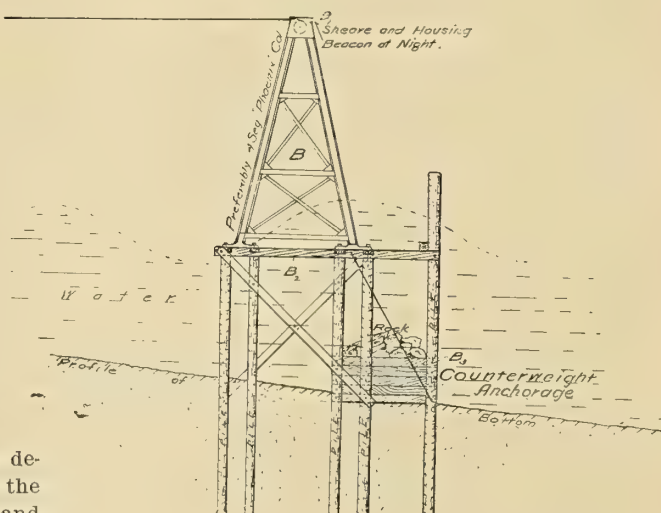
CHANCE CABLEWAY—SHORE END.

shown act as counterbalances. In operating the device the boat is hauled beneath the shore end of the cable, and hoisted to place by the sheave blocks and falls as shown in the drawing, marked D_1 D_2 . After hoisting to the level of the drum the fall ropes are made fast to clevis on blocks by two men, and the ends of ropes put on the platform D_2 . The release ropes D_3 D_4 are then attached, the brake D_5 , shown, being set. The remainder of the crew enters the boat after it has been hoisted to place and ready for release. The last man to enter the boat releases the pullback rope; the brake is then released and the boat runs by gravity to within about 50 ft. of the sea tower. The release ropes are then let go, releasing gradually or rapidly, and the boat drops to the water. The carriage D is pulled back to shore tower by the pullback rope. This device is the invention of G. W. Chance, C. E., Drexel Building, Philadelphia, Pa.

Armstrong Pipe Threading Machine.

A new machine, which has just been placed on the market by the Armstrong Mfg. Co., of Bridgeport, Conn., is shown in the accompanying illustration. It

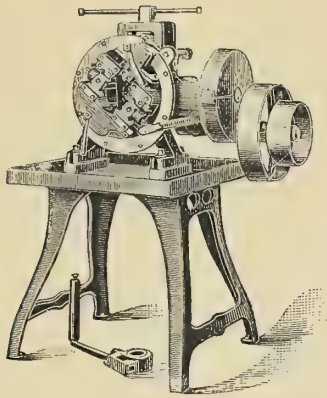
ard size without resetting. This is accomplished by an automatic locking device, which is operated by pulling a lever. This lever is shown at the left of the illustration. The dies, however, can be adjusted to variations of fittings the same as in the stock. All gears and moving parts of the machine run in oil, being enclosed in a chamber which covers them from chips and dust. The die head has no teeth on the part where it fits into the shell and forms a bearing, in this way preserving its bearing surfaces and making it impossible to get loose. In addition to this bearing being preserved by not revolving on top of the gear teeth, there is an inner journal of large diameter, thereby still increasing the wearing surface and preventing the die head from becoming loose. A powerful self-centering disk is used with this machine, and will hold the pipe, being threaded, with a light pressure of the lever. The construction of the machine ad-



CHANCE CABLEWAY—OFF-SHORE END.

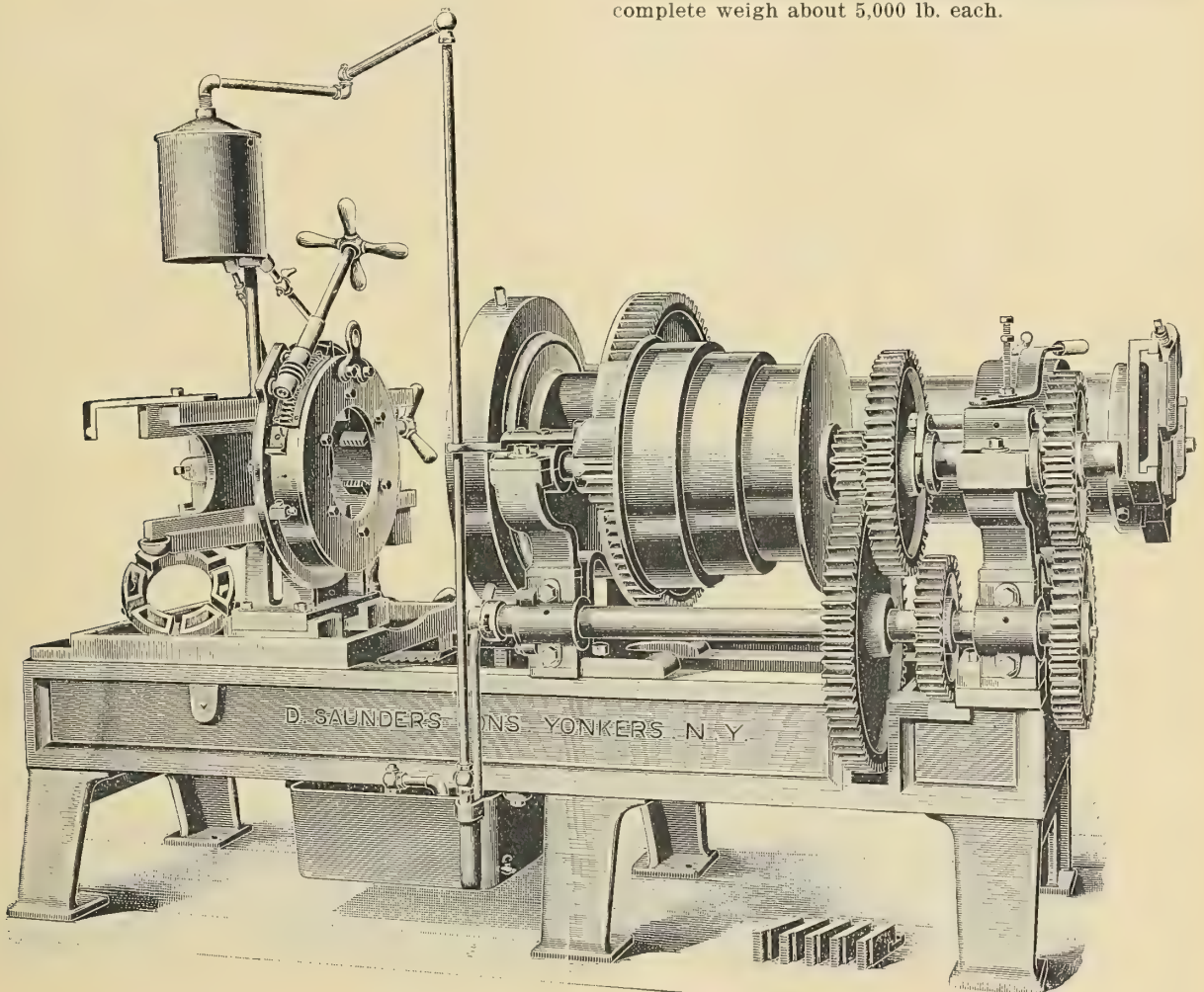
Pipe Threading and Cutting Machine.

The accompanying illustration shows the back view of a pipe threading and cutting machine especially adapted for use in marine and ship building plants, manufactured by D. Saunders' Sons, of Yonkers, New York. The machine is designed to thread and cut off pipe from one and a quarter to eight inches in diameter. The belting and gearing are arranged so as to obtain suitable power and speed for these various sizes of pipe, and so proportioned as to give a nearly uniform surface speed for each size. The use of large pulleys and tight belting is avoided. Variations of speed are obtained by cone pulleys as well as by gearing which is changed by the movement of a lever. No loose gears are used. Short pieces of pipe can be threaded without the use of a nipple chuck. After the pipe has been threaded the die head may be pushed to one side, allowing ample room for the pipe to pass through the cutting head without passing through the die head. By this arrangement pipe is alternately threaded and cut off without removing the die head from the machine. The steel jaws of the machine are adjustable to compensate for wear. An automatic oil pump, shown in the illustration, is attached to each machine. These machines complete weigh about 5,000 lb. each.



ARMSTRONG THREADING MACHINE.

mits of its being fastened to a bench or placed in an iron stand, which is furnished when desired. The machine here shown is designated as No. 00, and has a cutting off attachment for cutting pipes the same as the Armstrong Co.'s larger machines. The total weight of the new machine, without the stand, is 370 lb.



SAUNDERS' PIPE THREADING MACHINE.

MARINE ENGINEERING

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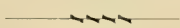
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IN a spirit of compromise Congress passed the Naval Appropriation Bill before adjournment last month, and for this reason the expected naval shipbuilding programme will not be immediately carried out. The bill as passed provides for the construction of three first-class battleships, three first-class armored cruisers, and three protected cruisers, and fixed the maximum price of armor at three hundred dollars a ton, with the further clause that none of the armored vessels shall be built until the armor is provided for. The number of ships is three less than the number recommended by the Navy Department, the difference being in the cruiser class. By fixing the price of armor at such a low figure, and adding the restriction of letting contracts only after the armor has been provided for, Congress has practically prevented the immediate construction of the new armored vessels. The armor dispute is one which has raged now for a long period without any satisfactory solution. It ought to be within the power of Congress to find out what is a fair price to pay for armor plate, and then, knowing this, to act intelligently. Setting an arbitrary price for material and holding the club of a Government plant over the head of the steel makers is not a very dignified position for the Government to occupy—in fact it might be mildly

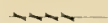
called intimidation. But even supposing the steel makers to be at fault, that they charge exorbitant prices and take advantage of the country's necessity, is that a good reason why the building of naval vessels for the defence of the honor and interests of the country should be stopped? It is hard to see how the opponents of the armor plate purchases can occupy any reasonable ground for their opposition—possibly the explanation is in some petty local or party advantage. Armor is a very expensive material, costly to produce, so much so, indeed, that the actual material bears little relation to the price. This has a parallel in many branches of manufacture. The loaf of bread is dear or cheap according to the rise or fall of the price of flour, but the price of the finer grades of lace is not based on the cost of linen thread. The production of armor plate necessitates the use of very costly apparatus, not only in forging the plates, but in machining them according to design. Then the orders for such material are neither sure nor continuous, and the makers run the risk of having an enormous amount of capital locked up in idle machinery. The price paid for armor by other nations could be readily ascertained, and if a comparison of such prices with those made by our steel makers showed that the latter were unreasonable or exorbitant an opportunity to bid could be given to all comers, home and foreign. This would settle the matter effectually, and there would be little chance of the orders going outside of this country. There seem to be some influences at work in Congress in cutting down the amount of appropriations where the Navy is concerned, which are not helpful to the best interests of the country in any sense. This was especially noticeable in the appropriations for the last lot of torpedo boats and destroyers, and cropped out in the case of the new monitors, and now appears in connection with armor plate. Some of the rural members of Congress seem to believe that war ships and their components are bought and sold like horses at a country show—for what they will bring. A horse buyer gets the horse at the lowest price he can, knowing the qualities of the beast will not be changed thereby; a ship is an entirely different proposition, for there the quality has a close relationship to the price. However patriotic a manufacturer may be, he can only afford to give the Government what it pays for—nothing more. It ought to be the aim of the Government to encourage manufacturers and help to develop the manufacturing resources of the country which could be drawn on in time of need. The proposition to build a Government armor plate plant

touches upon the ridiculous. To begin with, it would entail such a delay in the completion of the ships provided for in the bill that they would be almost out of date when completed. To operate such a plant with any degree of economy necessitates a certain and constant output. Do the advocates of the Government plant propose to build an indefinite number of armored vessels to keep the armor plant busy? Why, even the British Government, with its enormous Navy, does not manufacture a ton of armor plate. It has always been the policy of governments to so distribute the manufacture of war matériel that any local mishap, such as breakdown, fire, etc., will not paralyze the fighting resources of the nation. The recent action of Congress in this matter is childish and unworthy of the national legislature.



GREAT as was the achievement of the officers and men in bringing the U. S. S. *Oregon* safely around Cape Horn from the Pacific to the Atlantic, a run of 14,000 miles, it is now overshadowed by the voyage of the same ship from New York to Manila, a distance of 20,000 miles; and arriving out, in the words of Admiral Dewey, "in fit condition for any duty." This later run has not attracted nearly as much public attention as the run during the Spanish war, for the very natural reason that the country was then at war on the sea with a civilized power, while now the operations in the East are practically confined to the land, and are with a semi-civilized or barbarous foe. But the trip to Manila is really the more remarkable performance, from an engineering point of view. There was less incentive for those on board to put forth extraordinary efforts: on the previous run officers and men knew that they were on their way to fight for their country in the cause of liberty. On the other hand, however, the voyage just completed was made with the aid and benefit of the information and experience of the vessel's capabilities gained on the voyage around the Horn. That memorable voyage was in the nature of an experiment, and this calls attention to the apparent lack of confidence in the sailing qualities of the modern battleship. No other first-class ship of this type has made such records as the *Oregon* holds; though some long voyages have been accomplished by ships of other nations, notably the British. It is curious to compare the attitude of naval authorities with the practice which obtains in the mercantile marine. It is nothing remarkable for an ordinary cargo vessel to make a seventy-day

voyage under steam, and even in winter the ordinary tramp crosses the ocean without any one interested taking any special credit. The design and uses of such vessels are altogether dissimilar, and yet both are sea-going ships and as such should be able to meet any conditions. It may be that Navies have exercised an undue amount of caution in this respect and that the example set by the *Oregon* will be extensively followed.



RUMORS of the formation of a shipbuilders' trust on the Great Lakes are in the air, though at this time of writing nothing definite has transpired. This trust would embrace most of the large establishments, though several works would be on the outside. The modern tendency in manufacturing and commerce is toward concentration of effort. In these respects the ordinary stock company may be regarded as a trust, for it is organized, usually, to carry on a more extensive business under one management than could be undertaken independently by any of the stockholders. The result is, also usually, a benefit to the community at large, as in the case of the railroad and steamship corporations—the stockholders stand any losses. When, however, a trust or combination of separate interests is formed for the purpose of controlling the exclusive right, under patents, to manufacture certain articles or to control the natural resources of a country, the existence of such a trust is generally a luxury that the consumer pays for. In the case of most manufactured articles the carrying out of processes on a large scale gives the most economical results, and the expenses of marketing are largely reduced. In this, however, as in everything else in commercial life, there is a conflict of interests, for centralization of power dispenses with many capable and high-salaried men who managed the scattered units. Herein, we understand, lies the difficulty of forming a lake shipbuilders' trust. It is one thing to be the head of a large works, responsible to no official head, and quite another to be an employee accountable for every act. As a shipbuilders' trust would control no fundamental patents nor natural resources it is not likely that it would work to the disadvantage of the shipowner. A combination of several of the largest pump manufacturers of the country is also announced under the title of The International Steam Pump Company. This combination includes several of the well-known makers of marine pumps. The capital stock of the new organization is fixed at \$27,000,000.

MARINE BREAKDOWNS AND LOSSES.

NARRATIVE OF THE MISHAPS WHICH BEFELL
SOME WELL-KNOWN LINERS.

In marine circles the early months of the present year will long be remembered for the numbers of disasters and mishaps of every variety occasioned by the unusually severe weather. Leaving out of reckoning the wrecks of scores of small vessels, the losses of many large well-equipped steamships brought sadness to many homes and substantially decreased profits in shipping and insurance circles. It is rather remarkable, however, that in many instances the loss of a vessel or her total disablement was not attended by any loss of life. Some of the most notable mishaps are recounted here, with views of the steamships, *Bulgaria* of the Hamburg-American line, *Pavonia* of the Cunard line, and *Castilian* of the Allan line.

The Hamburg-American line freight and passenger steamship *Bulgaria* had an eventful voyage, which commenced January 28 at New York and ended February 24 at Ponta Delgada, Azores. The vessel left her pier at Hoboken on the Hudson river on her regular eastward trip to Hamburg, carrying a large cargo, many head of horses, and forty-one passengers in the steerage. Nothing unusual occurred until the night of February 1, when a terrific hurricane was encountered. The vessel was unable to make any headway and next afternoon Captain Schmidt decided to heave to. While being pounded by the waves the entire steering gear was carried away, according to the report of the ship's officers, and then the *Bulgaria* was helpless. Immense seas swept over the vessel, carrying away all sorts of gear and smashing windows and doors in the deck houses, and finally carrying overboard some of the hatch covers. Then the vessel commenced to fill, and she is said also to have sprung a leak. The horses carried stampeded and trampled each other or were dashed against the sides and killed, and those maimed were slaughtered. Later the vessel took a heavy list to port, and this increased the terror of the passengers, who were already demoralized. For seventy-two hours the crew labored to jettison the cargo and lighten the vessel, but the water kept rising in the holds and soon was nearly up to the grates in the fireroom, though the trimmers and firemen kept at work. On February 5 three steamships were sighted, and one of these, the tank steamer *Weehawken*, from Philadelphia for Hull, stood by and took off twenty-five passengers. She was unable to render further assistance, as her holds were full of water, and she lost all her small boats. This occurred in latitude 40 north, longitude 43 west. The *Weehawken* then proceeded to the Azores, where she landed the *Bulgaria's* passengers at Ponta Delgada. Her report of the condition of the *Bulgaria* at the time they parted caused intense anxiety for the safety of those on board the liner, and by many the *Bulgaria* was given up for lost. While the *Weehawken* was taking off the passengers four of the crew of the *Bulgaria* put off in an open boat, and after being blown about for several hours they were picked up by another of the steamers, the *Vittoria*. An officer and several of the crew of the *Vittoria* then got into the boat with the intention of going aboard the *Bulgaria*, but they could not reach her owing to the weather, which had become more severe, and they had great difficulty in getting back to their own ship. The Captain of the *Vittoria* determined to keep the *Bulgaria* company, so that he could give assistance when the storm abated, but in the night he lost sight of the distressed vessel, and he continued westward and put into Baltimore, where he landed the four mariners of the *Bulgaria* on February 22. Meanwhile on the *Bulgaria* matters improved somewhat after the *Weehawken* left, for the weather became calmer, and repairs were attempted. On February 11, however, stormy weather returned, and after

about three more days of drifting the British steamer *Antillian*, bound west from Liverpool for New Orleans, came up. She was asked to tow and passed a hawser to the *Bulgaria*. After several hours the tow line parted and another was secured, with a like result, so that finally the *Antillian* steamed away, as Captain Schmidt would not abandon his ship. February 17 the Norwegian bark *Helga* was signaled to report the *Bulgaria* "all well." Three days afterward, when the wind and sea had gone down considerably, repairs to the steering apparatus of the *Bulgaria* were completed and she proceeded under her own steam, shaping her course for Ponta Delgada. She averaged about ten knots speed and arrived in harbor February 24. Many of her passengers and crew had sustained severe injuries owing to their being thrown about violently during the storms. The seamanship displayed by the Captain and officers and the faithfulness and skill of the engineering staff called out widespread expressions of praise among marine folk, and the owners received a special message of congratulation from Emperor William. The *Bulgaria* is a new steamer of German build, having been launched from the yard of Blohm & Voss at Hamburg early last year. She is a large cargo-carrying boat of the intermediate type, measuring: Length, 500 ft.; beam, 62 ft.; depth, 38 ft. She is built of steel and is fitted with twin-screws, with quadruple-expansion balanced engines, with cylinders 21 1-3 in., 31 2-5 in., 46 in., and 66 1-2 in. by 48 in. stroke. She has Scotch boilers. Her gross tonnage is 10,961 tons.

The magnificent new Allan line steamship *Castilian*. Captain Richard Barrett, was lost on the morning of March 13, when in a thick fog she went on the Gannett Rock Ledges, about 11 miles southwest of Yarmouth Light, Nova Scotia. This was her maiden voyage and she had touched at Portland, Me., on her way out. When the mishap occurred the weather was moderate and the sea comparatively calm. Considerable water was reported after she struck as coming into the forward compartments. The chief officer and a boat's crew were sent for assistance and made a landing at Little River, and from there information of the mishap was conveyed to Yarmouth, from whence three steam tugs immediately came out. There were about fifty passengers on the *Castilian*. These were all taken off, together with a number of the crew, although the officers and some of the crew stood by the ship. The course which the vessel was steering at the time is hedged about with many dangers in the shape of ledges and reefs, and there are strong currents and tides. It was reported at the time that the compasses were deranged and that this accounted for the vessel being about twenty miles off her course. Subsequently the vessel broke in two and was a total loss. She carried a general cargo valued at about \$500,000 and many head of cattle. The *Castilian* was probably the largest vessel in the Canadian Atlantic trade. She was launched October 19, 1898, from the yard of Workman, Clark & Co., of Belfast, Ireland. Her design provided for a first-class passenger, cattle and cargo vessel of about 8,500 tons cargo capacity. Her dimensions were: Length, 470 ft.; beam, 53 ft. 9 in.; depth, 36 ft. She was built in excess of registry requirements, had a cellular bottom, nine water-tight compartments and three steel decks running the entire length fore and aft. There was a permanent shelter deck with bridge deck above. The cabin passengers were accommodated in the bridge enclosure amidships, where the furnishings and fittings were unusually artistic. The main saloon had accommodation for 100 passengers at table at one sitting. The roof of the deck house was used as a promenade, giving an unbroken stretch of 150 ft. in length at a height of about 25 ft. above the water. Very pleasant quarters for the second-class passengers were fitted aft, including a dining room with seating capacity for 150 persons. There was accommodation for a large number of steerage passengers on the main deck, and extensive accommodation for the large crew carried. Ex-

Allan Line S.S. Castilian.

Hamburg-American Line S.S. Bulgaria.

Cunard Line S.S. Patonia.

MISHAPS TO THESE TRANSATLANTIC LINERS CAUSED MUCH ANXIETY LATELY.—FOR PARTICULARS SEE OPPOSITE PAGE.



tensive refrigerating and electric light plants were fitted, and all the navigating and deck appliances were of the most improved types. She was fitted with comparatively powerful engines, and on her voyage out averaged about 300 miles a day.

The Cunard liner *Pavonia*, on the Boston-Liverpool route, set sail from Queenstown westbound late in January, and was towed into St. Michaels, Azores, February 18, by the British steamship *Wolviston*. Then was related an extraordinary story of misadventure. Shortly after the vessel left Queenstown she encountered a succession of hurricanes, and had to lay to at intervals for hours at a stretch. Finally in some unexplained manner the boilers got adrift and added to the terrors of the passengers by pounding about as the vessel rolled. The steamship *Colorado* was afterward sighted and passed a line to the *Pavonia*, but the towing bitts pulled out, and the Captain of the *Colorado* had to content himself with standing by for about twenty-four hours, when he lost sight of the *Pavonia*. Meanwhile the Cunarder was in a deplorable condition. The engineers, aided by their staff and deck officers and crew, made repeated efforts to secure the boilers, working in the semi-blackness of the stokehold unremittingly, while the ship was rolling and pitching terrifically and the water was waist high. The British steamship *Horatio* was sighted later, and in response to rocket signals approached and was notified of the *Pavonia's* condition. According to report the *Horatio* refused aid and went on her course. For another week the Cunarder drifted helplessly about, blown hither and thither by storms, until finally the steamship *Wolviston* was sighted. After about two days of effort in securing and losing tow lines the *Wolviston* made headway with the *Pavonia* in tow and the Azores were reached without further mishaps. The troubles of those on board the *Pavonia* were not over, however, as they had to land in life boats in a heavy gale. The conduct of most of the officers during those trying days was most warmly commended by the passengers, though there were many criticisms regarding the attitude of the Captain. The passengers were finally brought on here in the Portuguese steamship *Vega*, arriving at New York March 7. The *Pavonia*, like the other vessels of the Boston branch of the Cunard line, was not a flyer. She was a comparatively old ship, having been built at Clydebank in 1882. She is an iron barkentine-rigged single-screw ship of 5,500 gross tons, measuring: Length, 430 ft.; beam, 46 ft.; depth, 35 ft. She is fitted with two-cylinder compound engines and Scotch boilers.

The Dominion liner *Labrador*, bound east from St. Johns, N. B., and Halifax, N. S., for Liverpool, went ashore on McKenzie Rock, near Skerryvore Light on the Hebrides, on the morning of March 1. The ship was caught amidships and the seas broke over her so that the holds were soon full of water. The ship had good weather for several days out, but entered a fog bank some time before she was lost, and was away off her course at the time. The boats were got out and took off the passengers and crew, all of them being picked up by the steamship *Viking*, which happened to come up, except one boat load which made a landing at Skerryvore Light. This boat contained one Agoncillo, the blatant agent of Aguinaldo, leader of the Filipino rebels. His behavior was reported as being very cowardly when the vessel struck. The ship struck bottom very unexpectedly, and there was very little time to get away, but owing to the good discipline which prevailed no one was injured. The vessel had a valuable cargo and mails on board. The *Labrador* was a steel schooner-rigged screw steamer of about 4,700 gross tons and was built in 1891 by Harland & Wolff, Belfast, Ireland. Her dimensions were: Length, 400 ft.; beam, 47 ft.; depth, 28 ft. She was fitted with triple-expansion engines. This vessel held the record of the western passage from Liverpool to Halifax—about 7 1-2 days.

The Sloman line steamer *Moravia*, which was wrecked on the northeast bar of Sable Island about

February 12, is reported a total loss. She was bound from Hamburg for Boston and was overdue. She carried no passengers and had a crew of thirty, who got away safely in the boats, but before they reached land one of the officers died from exposure. The *Moravia* was an iron ship of about 2,400 tons, built about fifteen years ago at Glasgow.

Interesting Salvage Cases.

The extraordinary photograph here reproduced, together with the following particulars, are copied from the *Engineer*, London. (Engraving on opposite page.)

The Milwaukee was a fine cattle carrier of large dimensions, owned by Messrs. Elder, Demster & Co., Liverpool, and left the Tyne in ballast early in September. When off the Aberdeenshire coast during a dense fog she stranded on an outlying rock, and all attempts to get her off proved fruitless. Without unnecessary delay salvage operations were commenced by the Liverpool Salvage Company, but, as the forepart was held fast by the rocks and immovable, it was deemed advisable to cut her in two, ahead of the boiler-room bulkhead, the after part being uninjured, and thus save the most valuable part. Being favored with fine weather, this was accomplished, with the aid of dynamite, thus saving nearly two-thirds of the ship, containing the engines, boilers, etc. This portion was taken in tow for the Tyne, where she recently arrived safely. It is intended to build a new bow and float it into dock to join the old portion.

The employment of what might be termed the hydraulic method of freeing vessels which had gone aground on a soft bottom was used successfully in the case of the of the British battleship *Victorious*, which recently stranded at Port Said. Her grounding was caused by the failure of her anchors to hold, and the combined influences of a strong wind and heavy sea. She touched bottom in about 25 ft. of water and later resisted all efforts to float her by the aid of tugs. A considerable quantity of coal, ammunition and other stores was removed to lighten the vessel. Then two boats with powerful pumps were put at work discharging water under pressure on the starboard side of the battleship, the nozzles of the discharge pipes being worked about below water where the bottom of the vessel rested on the sand. On the port side a suction dredge was put at work which removed the sand that was stirred up by the action of the jets. After about two days' work a sufficient excavation was made in the bottom to give a draught of water in which the vessel could float, and with the aid of tugs she was dragged out to deep water. The *Victorious* is one of the new British battleships, having been built at Chatham Dockyard in 1895. Her dimensions are: Length, 390 ft.; beam, 75 ft.; mean draught, 27 ft. 6 in.; displacement, 14,900 tons. A somewhat similar method was employed in freeing the Russian armored cruiser *Rossia*, which went aground in the river Neva. She settled nearly three feet in the bottom, which was composed of muddy sand mixed with a considerable percentage of pebbles. As the accident occurred in mid-winter, the vessel was soon frozen in, and all efforts to pull her off with tugs were useless. The hydraulic method was then employed, the nozzle from the discharge pumps being worked on the bottom where the vessel touched, and in this way she was floated after about three weeks' work, the conditions below water being explored from time to time by divers. The *Rossia* is an armored cruiser of the following dimensions: Length, 480 ft.; beam, 68 ft.; draught, 26 ft. Her displacement is 12,200 tons, and she is fitted with engines of 18,000 horse power, under forced draft, which give a maximum speed of 20 knots. She is fitted with triple screws driven by three sets of triple-expansion engines, and Belleville water-tube boilers. This fine vessel attended the British naval review at Spithead in 1897, and together with our *Brooklyn* attracted a great deal of attention. The *Rossia* was built at St. Petersburg.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—MATERIALS OF ENGINEERING CONSTRUCTION—II.

BY DR. WILLIAM FREDERICK DURAND.

[2] MALLEABLE IRON.

(1) *Composition and Manufacture.* If a casting of hard, white iron, or one with a large proportion of combined carbon, be packed in some material which will not fuse at a red heat, which will exclude the air, support the piece and prevent deformation when hot, and if it be then subjected to continuous red heat for some days, the combined carbon will be separated from the iron, but will not be able to collect together in flakes or scales or to form the same structure as in soft, gray cast iron. In consequence the iron crystals remain in more intimate contact, much as in steel, and the tensile strength and toughness are greatly increased.

It has long been supposed that this operation involved an actual withdrawal of the carbon from the iron, and to this end the substances usually employed are either the common red oxide of iron in the form of hematite iron ore, or the black oxide in the form of mill scale, or the corresponding oxide of manganese.

cooling slowly, usually show a considerable proportion of graphite carbon.

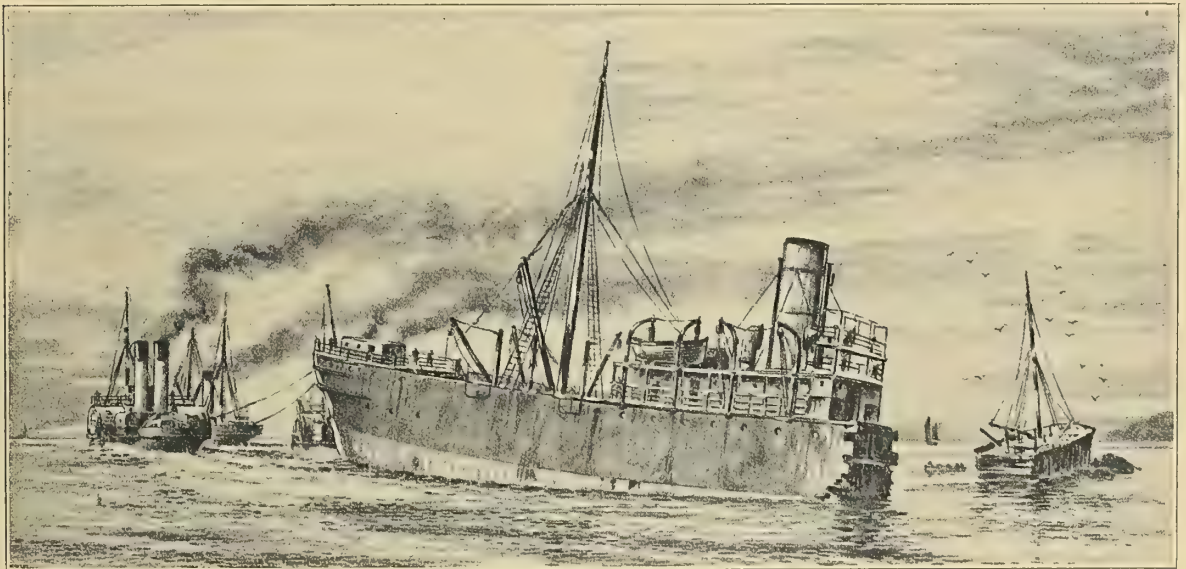
To carry out the process the castings are embedded in the material selected. The whole is then inclosed in a cast-iron box or pot and is subjected to a full red heat for from two or three days to as many weeks, depending on the size of the piece.

(2) *Physical and Mechanical Properties.* Outside of the numerical information, to be given later, attention may be called to the ductility of malleable iron, which is from four to six times that of cast iron, though only about one-tenth that of wrought iron. Nevertheless good malleable iron can be bent and twisted to a very considerable extent before breaking, and its ability to withstand blows or shocks is very much greater than cast iron. Malleable iron may with care be forged and welded, and it may be case hardened much as with wrought iron.

(3) *Uses in Marine Engineering.* Malleable iron is used for junction boxes and for pipe fittings in certain varieties of water-tube boilers, and to some extent for general pipe fittings on board ship. It would seem that the use of this material might with advantage be extended to many parts in which more strength and toughness are required than can be provided by cast iron.

[3] WROUGHT IRON.

(1) *Composition and Manufacture.* Wrought iron is nearly pure iron mixed with more or less slag.



AFTER END OF THE S.S. MILWAUKEE IN TOW OFF THE COAST OF SCOTLAND.

These have a decarbonizing effect; that is, under the conditions existing they will to some extent withdraw the carbon from the surface layer of iron. Analyses of malleable iron show, however, that only to a slight extent is the carbon actually withdrawn as a whole, and that the principal change is in the condition of the carbon, as above explained. The surface effect, however, extending in, as it does, for perhaps 1-16 in., is undoubtedly a valuable feature, and while a good quality of malleable iron has been made by the use of river sand as a packing medium, the use of the substances mentioned above is rather to be preferred.

In order that the process may be successful, the iron must have nearly all the carbon in the combined state, and must be low in sulphur, as the latter substance is found to greatly increase the time necessary. It has been customary to use only good charcoal-melted iron in which the sulphur is very low, though a coke-melted iron is quite as suitable, provided the proportion of sulphur is correspondingly small. The process can rarely be applied to very large castings, because such,

Nearly all the wrought iron used in modern times is made by the *puddling* process. For the details of this process reference may be had to text-books on metallurgy. We can only note here that in a furnace somewhat similar to the *open-hearth* referred to in [4] most of the carbon, silicon and other special ingredients of cast iron are removed by the combined action of the flame and of a molten bath of slag or fluxing material consisting chiefly of black oxide of iron. As this process approaches completion small bits of nearly pure iron begin to separate out from the bath of melted slag and unite together. This is helped along by the puddling bar, and after the iron has thus become separated from the liquid slag it is taken out, hammered or squeezed, and rolled down into bars or plates. Some of the slag is necessarily retained in the iron and by the process of manufacture is drawn out into fine threads, giving to the iron a stringy or fibrous appearance when nicked and bent over or when pulled apart.

The proportion of carbon in wrought iron is very

small, ranging from .02 to .20 of one per cent. In addition, small amounts of sulphur, phosphorus, silicon and manganese are usually present.

The proportion of sulphur should not exceed .01 of one per cent. Excess of sulphur makes the iron *red-short*, that is, brittle, when red hot.

The proportion of phosphorus may vary from .05 to .25 of one per cent. Excess of phosphorus makes the metal *cold-short*, that is, brittle when cold.

The proportion of silicon may vary from .05 to .30 of one per cent.

The proportion of manganese may vary from .005 to .05 of one per cent. The influence of the silicon and manganese is usually slight and unimportant.

(2) *Special Properties.* Wrought iron is malleable and ductile, and may be rolled, forged, flanged and welded. It cannot be hardened as steel, though by the process of case-hardening a surface layer of steel is formed and may be hardened. Wrought iron may be welded, because for a considerable range of temperature below melting (which takes place only at a very high temperature indeed) the iron becomes soft and plastic, and two pieces pressed together in this condition unite and form on cooling a junction nearly as strong as the solid metal. In order to be thus successful, however, the iron must be heated sufficiently to bring it to the plastic condition, yet not overheated, and there must be employed a flux (usually borax) which will unite with the iron oxide and other impurities at the joint, and form a thin liquid slag which may be readily pressed out in the operation, thus allowing the clean metal faces of the iron to effect a union as desired.

(3) *Uses in Marine Engineering.* In modern practice the place of wrought iron in marine engineering has been almost entirely taken by steel. Its former office was for all moving parts requiring strength and toughness. It is still used to some extent for the stay bolts and braces of boilers, and for boiler tubes.

[5] STEEL.

(1) *General Composition.* The properties of steel depend partly on the proportions of carbon and other ingredients which it may contain, and partly on the process of manufacture. The proportion of carbon is intermediate between that for wrought iron and for cast iron. In the so-called mild or structural steel the carbon is usually from 1-10 to 1-4 or 1-3 of one per cent. In spring steel the carbon proportion is somewhat greater, and in high carbon grades such as are used for tool steel, etc., the carbon is from .6 to 1.2 per cent. In addition to the carbon there may be sulphur, phosphorus, silicon and manganese in varying but very small amounts.

From the proportion of carbon it follows that steel may be made either by increasing the proportion in wrought iron or decreasing the proportion in cast iron. The earlier processes followed the first method, and high-grade steels are still made in this way by the *crucible* process.

(2) *Crucible Steel.* In this process a pure grade of wrought iron is rolled out into flat bars. These are then cut and piled and packed with intermediate layers of charcoal and subjected to a high temperature for several days. This recarbonizes or adds carbon to the wrought iron, and thus makes what is then called *cement* or *blister* steel. These bars are then broken into pieces of convenient size, placed in small crucibles, melted, and cast into bars or into such forms as are desired.

Note.—Mild or structural steel is made wholly by the second general method—the reduction of the proportion of carbon in cast iron. There are two general processes, known as the *Bessemer* and the *Siemens Martin* or *Open-hearth*.

(3) *Bessemer Process.* In this process the carbon and silicon are burned almost entirely out of the cast iron by forcing an air blast through the molten iron in a vessel known as a converter. A small amount of *spiegel eisen* or iron rich in carbon and manganese is then added in such weight as to make the proportion

of carbon and manganese suitable for the charge as a whole. The steel thus formed is then cast into ingots or into such forms as may be desired.

In this process no sulphur or phosphorus is removed, so that it is necessary to use a cast iron very nearly free from these ingredients in order that the steel may have the properties desired. A modification by means of which the phosphorus is removed, and known as the *basic* Bessemer process, is used to some extent. In this, calcined or burnt lime is added to the charge just before pouring. This unites with the phosphorus, removes it from the steel, and brings it into the slag. In the basic process the lining of the converter is made of gannister or a calcined magnesia limestone, in order that it may not also be attacked by the added limestone and the resulting slag.

In that form of Bessemer process first noted, and often known as the *acid* process in distinction from the latter or basic process, the lining of the converter is of ordinary fire clay or like material.

The removal of the phosphorus by the basic process makes possible the use of an inferior grade of cast iron. At the same time, engineers are not altogether agreed as to the relative values of the two products, and many prefer steel made by the acid process from an iron nearly free from phosphorus at the start.

(4) *The Open-hearth Process.* In this process a charge of material consisting of wrought iron, cast iron, steel scrap, and sometimes certain ores, is melted on the hearth of a reverberatory furnace heated by gas fuel on the Siemens Martin or regenerative system. The carbon is thus partially burned out in much the same manner as for wrought iron, and the proportion of carbon is brought down to the desired point or slightly below. A charge of *spiegel-eisen* or ferro-manganese is then added in order that the manganese may act on any oxide of iron slag which remains in the bath, and which would make the steel red-short if allowed to form a part of the charge. The manganese separates the iron out from the oxide, returns it to the bath, while the carbon joins in with that already present, and thus produces the desired proportions.

Here as with the similar operation with the Bessemer converter there is no removal of either sulphur or phosphorus, and only materials nearly free from these ingredients can be used for steel of satisfactory quality. With very low carbon, however, a little phosphorus seems to be desirable to add strength to the metal. This limitation of the available materials has led, as with the Bessemer process, to the use of calcined limestone, which unites with most of the phosphorus and holds it in the slag. Here, as in the Bessemer process also, it is necessary to use a basic lining for the furnace, and it is known as the *basic* open-hearth process. By distinction the method without the use of the limestone has come to be known as the *acid* open-hearth process.

As between the products of these two kinds of open-hearth process, there is much difference of opinion among engineers. *Either* will produce good steel with proper care, and *neither* will without it. It is usually considered sufficient to specify the allowable limits for the proportions of phosphorus and sulphur and leave the choice of the acid or basic processes to the maker.

(5) *Open-hearth and Bessemer Steels Compared.* Open-hearth steel is usually preferred for structural material in marine engineering. This is because:

(a) It seems to be more reliable and less subject to unexpected or unexplainable failures than the Bessemer product.

(b) Analysis shows that it is much more homogeneous in composition than Bessemer steel, and experience shows that it is much more uniform in physical quality. This is due to the process of manufacture, which is much more favorable to a thorough mixing of the charge than in the Bessemer process.

(c) The open-hearth steel may be tested from time to time during the operation, so that its composition

may be determined and adjusted to fulfil specified conditions. This is not possible with the Bessemer process, and the latter product is therefore not under so good control as is the open-hearth.

(6) *Influence of Sulphur on Steel.* Sulphur makes steel red-short or brittle when hot, and interferes with its forging and welding properties. Manganese tends to counteract the bad effects of sulphur. Good crucible steel has rarely more than .01 of one per cent. In structural steel the proportion may vary from .02 to .08 or .10 of one per cent. When possible it should be reduced to not more than .03 or .04 of one per cent.

(7) *Influence of Phosphorus on Steel.* Phosphorus increases the tensile strength and raises the elastic limit of low carbon or structural steel, but at the expense of its ductility and toughness or ability to withstand shocks and irregularly applied loads. It is thus considered as a dangerous ingredient, and the amount allowable should be carefully specified. This is usually placed from .02 to .10 of one per cent.

(8) *Influence of Silicon on Steel.* Silicon tends to increase the tensile strength and to reduce the ductility of steel. It also increases the soundness of ingots and castings, and by reducing the iron oxide tends to prevent red-shortness. The process of manufacture usually removes nearly all of the silicon, so that it is not an element likely to give trouble to the steel maker. The proportion allowed should not be more than from .10 to .20 of one per cent.

(9) *Influence of Manganese on Steel.* This element is believed to increase hardness and fluidity, and to raise the elastic limit and increase the tensile strength. It also removes iron oxide and sulphur, and tends to counteract the influence of such amounts of sulphur and phosphorus as may remain. It is thus an important factor in preventing red-shortness. The proportion needed to obtain these valuable effects is usually found between .20 and .50 of one per cent.

(10) *Semi-steel.* A metal bearing this trade name has in recent years attracted favorable attention among engineers, and has come into considerable use where somewhat greater strength and toughness are required than can be provided by cast iron.

Semi-steel is made by melting up mild steel scrap, such as punchings and clippings of boiler plate, with cast iron pig, in the proportion of about 25 or 30 per cent of the former to 75 or 70 per cent of the latter. The presence of manganese and other special fluxes in small proportions is also found to add essentially to the strength, toughness and good machining qualities of the product. In this way is obtained a material having a tensile strength of 35,000 lb. or over, and a toughness and ability to withstand shocks decidedly greater than for cast iron, and with fairly good machining qualities. Semi-steel casts as readily as most grades of cast iron, and its shrinkage and general manipulation are about the same. The chief drawback seems to lie in the danger of hardness under the lathe, planer or boring tool, but with the proper mixtures this is avoided, and a material very satisfactory for many purposes in marine engineering is thus produced.

(11) *Mechanical Properties of Steel.* The tensile strength of the lowest carbon steel, say about .10 of one per cent carbon, is usually not above from 50,000 to 55,000 lb. per square inch of section. The strength increases with the increase of carbon, and with not above the usual proportions of sulphur and phosphorus, quite uniformly. Experiment shows that under these circumstances the strength will increase up to 75,000 lb. per square inch, or higher, at the rate of from 1,200 to 1,500 lb. per .01 of one per cent of carbon added. At the same time, with the increase in strength the ductility decreases, so that a proper choice must be made according to the particular uses for which the steel is intended. With the best grades of tool steel with carbon ranging from 1-2 to 1 per cent and over, the strength ranges from 80,000 lb.

upward to 120,000 lb., and even higher in exceptional cases.

Flange and rivet steel must be tough and ductile in the highest degree. Such steel has usually a tensile strength between 50,000 and 60,000 lb. and an elastic limit of 30,000 to 40,000 lb. Its elongation in 8 in. is from 30 to 35 per cent, and reduction of area at the ruptured section from 50 to 60 per cent. It will bend cold on itself and close down flat under hammer or press, up to a thickness of 3-4 in. to 1 in. without a sign of fracture.

Shell steel, used for boiler shells, etc., has usually a strength between 55,000 and 65,000 lb.; elastic limit from 33,000 to 45,000 lb.; elongation in 8 in. of 25 to 30 per cent, and reduction of area of 50 to 60 per cent.

For shafting the quality of the steel is about the same as for shell plates. For piston and connecting rods the strength is rather higher, and ductility somewhat lower.

For steel castings the strength required is usually from 60,000 to 65,000 lb., with an elongation in 8 in. of from 10 to 15 per cent.

Notes of Interest.

Contracts are reported definitely closed for the construction of the two new steamships for the Pacific Mail line, which are to be built at Newport News, Va. The dimensions given are: Length, 550 ft.; beam, 63 ft.; depth, 40 ft. A sea speed of 18 knots is figured on.

The International Steam Pump Company has been organized in the State of New Jersey and includes most of the leading pump manufacturers of the country. The new company has a capital of \$27,500,000, with preferred stock amounting to \$12,500,000 and \$15,000,000 common stock. Many of the concerns in this combine manufacture pumps for marine uses.

Major H. M. Adams, U. S. Engineers, has received the approval of the Secretary of War to his specifications for contracts for improving the East Channel and the Bay Ridge and Red Hook Channels in New York Harbor, under the River and Harbor act. Major Adams will advertise for bids thirty days, and if contractors do not bid for excavating the 39,000,000 cu. yd. at ten cents per yard the Government will build its own plant. The contractor will have one year less one day after signing his contract to begin work.

The appreciation of the nation, expressed through Congress, of the services rendered to his country by George Dewey, U. S. N., was fitly shown by his promotion to the rank of Admiral. This is a rare distinction in the Naval service, the rank having been conferred previously on two occasions only in the history of the United States. By his promotion Admiral Dewey becomes the ranking military officer of the entire Government service, and the date of his retirement is left to be fixed by him whenever he chooses. When the nomination was made and confirmed Secretary Long cabled authority to Admiral Dewey to hoist the flag of an Admiral and to wear the uniform of his new rank. He is hereafter entitled to a salute of seventeen guns.

The Personnel bill, readjusting the rank of officers of the Staff corps and abolishing the Engineer corps of the Navy by amalgamating it with the Line, was passed by Congress before it adjourned early last month. The naval authorities are now at work on the rearrangement of the Navy list in accordance with the provisions of the new law. The changes made by this law in the naval organization are very radical, and among these is one permitting seamen to attain commissioned rank under certain circumstances. A new class of warrant officers, to be known as Warrant Machinists, has been created. In a future issue we shall discuss this most important act.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XVII.

BY WM. BAXTER, JR.

Circuit Breakers.

A circuit breaker is a device which is so arranged that it breaks, or opens, the circuit when the current flowing therein reaches a strength at which the apparatus is set to operate; in other words, the action is controlled by the strength of the current. An electric current flowing in any circuit generates heat therein, and the stronger the current the more heat; therefore, if the strength is allowed to increase without limit, a point is soon reached where the amount of heat gener-

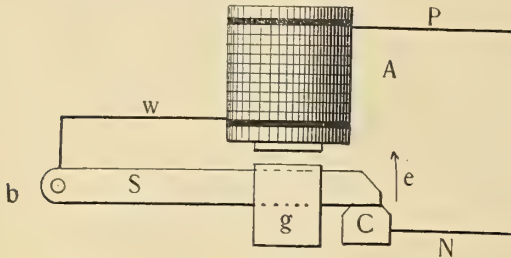


FIG. 94.

ated is more than the wire can get rid of by radiation, and as a consequence the temperature rises to a destructive point. A circuit breaker, therefore, is a protective device whose object is to open the circuit before the temperature reaches a dangerous degree.

A circuit breaker in its most elementary form is illustrated in Fig. 94. In this diagram A represents an electro magnet, the ends of the wire coil wound upon it being connected with the wires P and w. The lever S is a switch which closes the circuit between the end of wire w and the contact c which forms the terminal of wire N. The square, marked g, is a weight made of iron, and it acts normally to hold S down upon c. The magnet A being energized by the current passing through the coil wound upon it, will exert a small pull upon g when the current is weak, but this pull will increase as the current strength increases. If we assume the current to increase continually, it is evident that after a while it will become so strong that the pull of the magnet will be sufficient to lift g, and when this

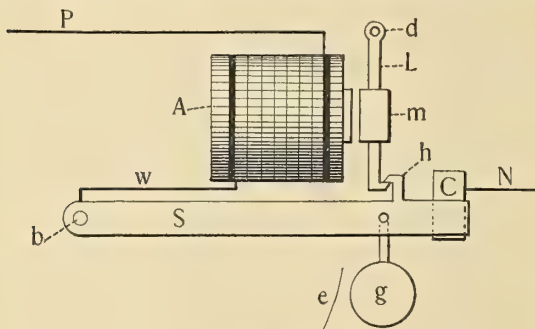


FIG. 95.

action takes place the circuit between P and N will be interrupted at the junction of c and the end of S.

This simple device is a perfect circuit breaker and will be very sensitive in its action if the pivot at b upon which S swings is made as nearly frictionless as possible. It would not be suited, however, to circuits carrying strong currents, as the separation between c and S is small, being limited by the distance between the top of g and the end of the magnet A. While a weak current could not jump across the space between the end of S and top of c when S is raised to its high-

est point, a strong one could; hence, to make a circuit breaker that would be serviceable for the latter purpose it would be necessary to devise a construction that would permit S to move much farther away from c when moved by the force of the magnet. This result can be accomplished by the construction shown in Fig. 96. In this figure it will be seen that S is held in

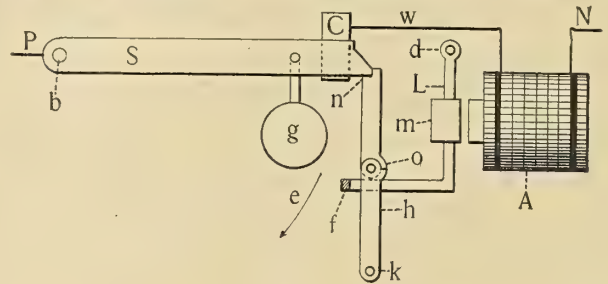


FIG. 96.

place by the hook h which engages with a similar hook upon the end of the lever L, the latter being pivoted at d so as to swing freely in a horizontal direction. The block m is made of iron, so that it may be attracted by the magnet A. When the current becomes sufficiently strong to cause A to act, L swings from under hook h and then S swings in the direction of arrow e, and thus

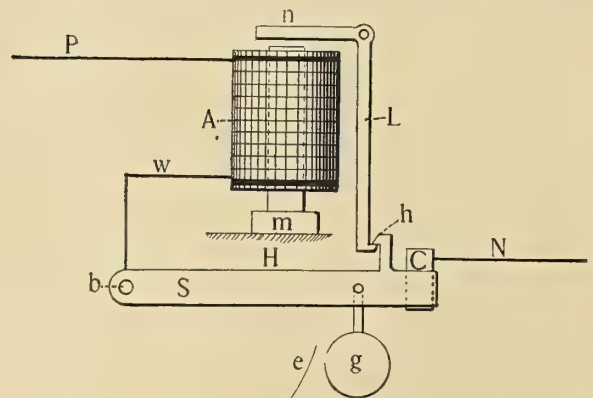


FIG. 97.

the separation between its end and c becomes many times as great as in Fig. 94.

It will be noticed at once, that while this construction enables us to obtain as great a separation as may be desired, the action must be very torpid, for the end of L must slide from under h against the friction produced by the weight of g and of S. This difficulty we can surmount by adopting the construction shown in Fig. 96. In this diagram it will be seen that S is held up by the jointed lever h, which is constructed upon

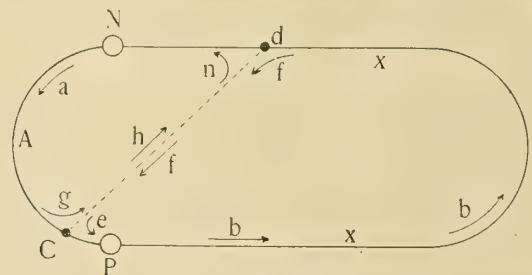


FIG. 98.

the toggle principle, the projections at o serving to keep it straight. The block m upon the lever L is acted upon in the same manner as in Fig. 95, but the end f does not have to slide against any frictional

force, hence it moves freely and striking *h* throws its center to the right and then the end *n* drops and allows *S* to fall freely.

The diagram Fig. 97 shows another way in which the switch *S* can be held so that the friction of the

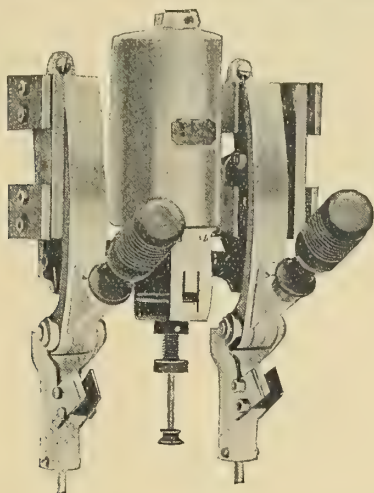


FIG. 99.

support may not interfere with its free release. In this arrangement the magnet *A* is of the solenoid type, that is, it consists of a coil of wire with an iron core *m* which fits loosely in the center opening. This core rests upon a suitable support *H*. When the current becomes sufficiently strong, it draws *m* upward, and

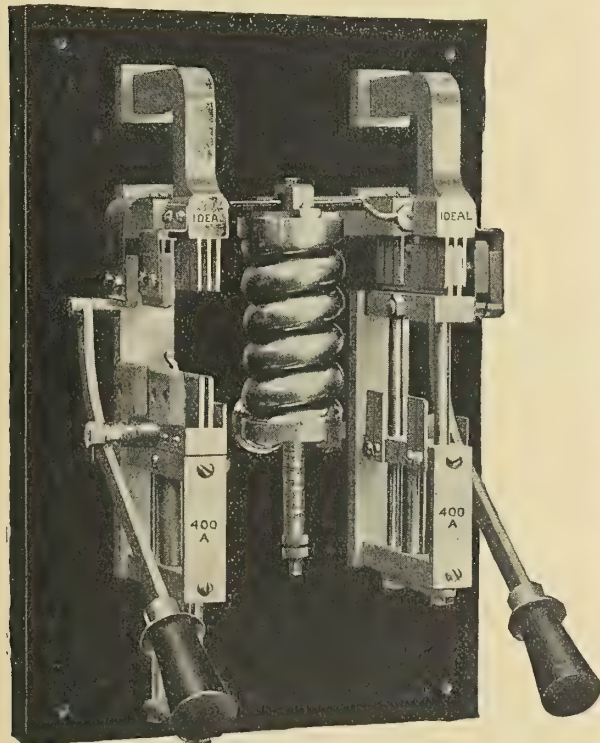


FIG. 100.

the velocity with which it is raised is such that its upper end strikes *n* violently, giving it a hammer blow. This blow moves *L* and causes it to disengage from the hook *h*, thus allowing *S* to fall.

The principles of action illustrated in Figs. 96 and 97 are used, more or less modified, in many forms of circuit breakers, while in others different forms of

construction are used. As can be readily seen, the object to be accomplished is to get rid of the friction of the construction shown in Fig. 95, and evidently there are many ways in which this may be accomplished.

Circuit breakers, like switches, are classified as single-pole and multipole; of the latter type the two-pole is the only one commonly used. For the protection of a single circuit, a two-pole circuit breaker is in most cases better than the single-pole device, although at a first glance it might appear that a breaker that opens the circuit at one point would be as effective as one that opens it at two, since one interruption in a circuit is sufficient to stop the flow of current. The reason why the two-pole circuit breaker affords greater protection, in most cases, is that if a circuit is grounded, through a defect in the insulation, opening it at a single point may not stop the flow of current in the entire circuit, as through the defect in the insulation a short circuit may be completed. This condition of things can be better explained by the aid of Fig. 98, which is a diagram representing a generator and its external circuit. The left-hand portion of the curve, marked *A*, represents the armature wire, and *X X* represents the external circuit, *N* and *P* being the commutator brushes. The armature is supposed to generate a current in the direction of arrow *a*, and this flows through the external circuit in the direction of arrows *b b*. If there is a defect in the insulation of the armature wire, so that the current can escape to the iron core, no damage will be done if there is no other ground. Suppose the armature defect is at the point *c*, and suppose that another ground is formed in the external circuit at *d*. Now the portion of the armature between *N* and *c* will generate a current that will flow in the direction of arrow *a*, and this when it reaches point *c* will follow arrow *g* and *h* to point *d* and then return to the armature as indicated by arrow *n*. The small portion of the armature from *c* to *P* also tends to generate a current in the direction of arrow *e*, but this current cannot flow through the external circuit in the direction of arrows *b b* unless it can pass from point *d* to *N* direct, for if it should follow the ground path from *d* to *c* in the direction of arrows *f f* it would have to flow against the current coming from the larger half of the armature, and this it could not do. Now suppose we have the circuit protected by a circuit breaker that will open the connection between *N* and *d*, then it is evident that the current generated in the portion of the armature between *N* and *c* will not be able to flow, for it can only pass as far as arrow *n*, since there is a break between *d* and *N*. Thus the circuit breaker placed between *d* and *N* will stop the flow of current through the larger part *o n* of the armature, between *N* and *c*, but as on this account there will be an opposing current flowing between *c* and *d* the current generated in the armature between *c* and *P* will follow the circuit in the direction of arrows *b b* and *f f e*. From this we see that the single circuit breaker placed between *N* and point *d* will not entirely stop the flow of current when the short circuit between *c* and *d* is formed. If, however, we place another circuit breaker next to *P*, then the circuit on both sides of the ground connections *c* and *d* will be broken, and the current will be completely interrupted.

From the foregoing it can be seen that if we desire complete protection it is necessary to use a two-pole circuit breaker, or two single-pole ones. As in diagram Fig. 98 *P* and *N* represent the brushes or binding posts of the generator, they are in reality close together, and can be more easily connected with one double-pole breaker than with two of the single-pole type.

Figs. 99 and 100 show two designs of two-pole circuit breakers that are used extensively. In the first figure both sides of the instrument are shown in the closed position, while in the second the switch on the right side is closed and that on the left is open. The handles are for the purpose of replacing switches when they are thrown open by the action of the current.

ENGINEERS' DICTIONARY—XVI.

Evaporator.—An apparatus for making fresh water to supply the loss in the boiler feed. The usual form of evaporator consists of a series of nests or coils of pipe contained within a chamber as shown in Fig. 66. The chamber contains sea water, and steam from the boilers or from one of the receivers is passed inside the tubes. The heat in the steam passes through the tubes and forms steam or vapor of lower pressure on the salt water side. The chamber is connected with the condenser or with the L. P. receiver, and the steam formed in the evaporator is thus passed into the main circuit and serves to make up the loss of fresh water due to leakage at safety valves, joints, glands, etc., and to loss of steam used in auxiliaries and not returned to the condenser. At the same time the

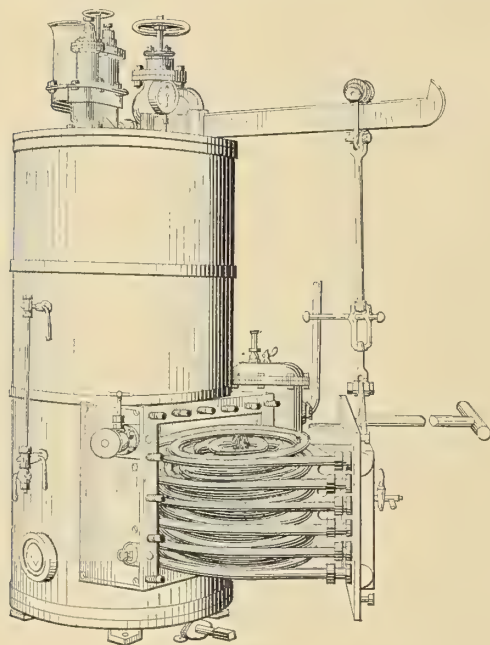


FIG. 66.

water formed in the coils by the loss of heat is trapped out and returned to the feed, so that there is no expenditure of *steam* by the operation, but only of the *heat* which it carries. The coils on the outer or salt water side become naturally coated with scale, so that they must be cleaned from time to time. To this end they are usually arranged, as shown in the figure, so that they may be readily removed, cleaned, and returned in place.

Exhaust Cock or Valve.—A cock or valve serving to allow or control the discharge of some liquid, vapor or gas, or its transfer from one receptacle to another.

Exhaust Pipe.—A pipe leading from an exhaust valve for carrying the liquid vapor or gas to the place desired.

Exhaust Lap.—The amount by which a slide valve when in its mid-position covers the port on the exhaust side.

Exhaust Lead.—The amount by which a slide valve port is open on the exhaust side when the engine is at the end of the stroke.

Exhaust Port.—An opening through which air, steam or other vapor is *exhausted* or removed from a cylinder after having completed its work therein.

Exhaust Steam.—Steam which has completed its work in a given cylinder and is passing out through an exhaust port and pipe, either to the air, to the condenser, or to another cylinder. In a multiple-expan-

sion engine the exhaust from one cylinder is the supply for the next beyond, while the final exhaust leads from the low-pressure cylinder to the condenser.

Expansion.—All gases and vapors tend to expand, or to occupy a larger volume. The term *expansion* refers to this general tendency. The expansion of steam or the expansive use of steam refers to the now almost universal mode of using steam, in which after being allowed by the steam valve to enter and fill a portion of the cylinder, the opening for entrance is closed, and the steam thus admitted acts for the remainder of the stroke by its expansive force alone. The *number of expansions* means the ratio between the volume at the end and at the beginning of the expansion; or it is the number by which the original volume of steam is multiplied in the operation of expansion. In modern triple-expansion engines using steam from 150 to 200 lb. pressure, the total number of expansions is usually found between 8 or 9 and 11 or 12. With quadruple-expansion engines and rather higher pressures of steam the number of expansions may rise to 13 or 14 or even higher.

Expansion Gear.—That part of the valve gear which is especially concerned in cutting off the steam and in thus producing its expansion or expansive action. In most modern marine valve gears all separate expansion gear is omitted, and the entire control of the steam is effected by the main valve gear alone.

Expander or Expanding Tool.—A tool for expanding or forcing out the metal of a boiler tube against the metal of the tube sheet, and thus making a steam- and water-tight joint. A common form of expander is shown in Fig 67. It consists of a frame or casing carrying three steel rollers as shown. These rollers instead of running in fixed bearings at the ends are free to move outward or inward in radial slots in the casing. When in use the tool is placed in the end of the tube with the rollers opposite the tube-sheet. A taper steel mandrel is then put in through the central hole between the rollers, forcing them outward against the metal of the tube. This mandrel is then turned by means of a crank or handle attached to the outer end. In this way the mandrel turns between the rollers, while the latter roll between the mandrel and the metal of the tube, thus gradually traveling around the inner surface and rolling the metal outward against the tube sheet. As the operation goes on the mandrel is driven gradually in, thus rolling the metal outward

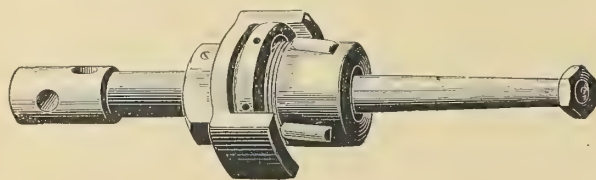


FIG. 67.

until the desired effect is produced. In the form shown the rollers are placed slightly oblique so that their axes are not quite parallel with that of the tube. In such case when turned in one direction they tend gradually to feed themselves into the tube, and when in the other to back out. In this way the instrument becomes self-feeding, and its entire action is continuous and regular.

Eye-bolt.—See *Bolt*.

Feathering Float.—A paddle-wheel float carried on a form of lever and operated by connection to an eccentric or equivalent device, so that the float shall enter and leave the water in a position nearly or quite vertical. The object of this is to avoid a certain loss due to the obliquity of action in the common form of float. Two forms of mechanism for operating feathering floats are shown in Figs. 68, 69. In Fig. 68 the links similar to *A B* are all pivoted at *A*. This link actuates the lever *B C* and blade *D E* as shown, and similarly for the others. In Fig. 69 *H B* is a drive link

actuated by an eccentric with center at A. The remainder of the links are pivoted to the eccentric strap as shown, and are connected to blades similar to D E,

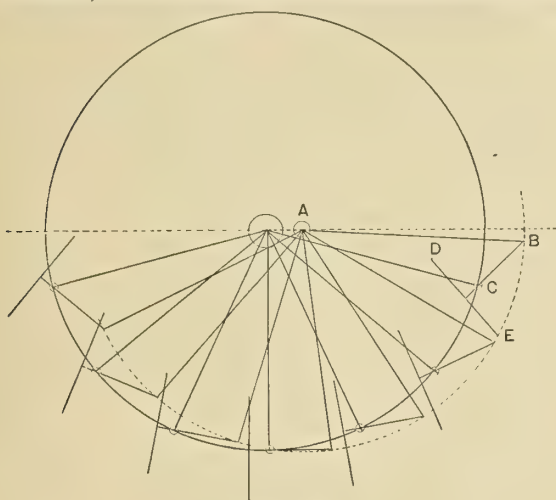


FIG. 68.

as in the diagram. In both diagrams the plane of the blade may be beyond the pivot C as shown, or it may

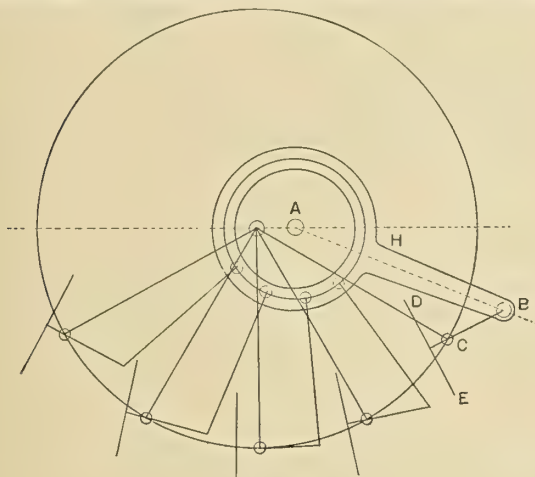


FIG. 69.

contain C, or it may lie between B and C. The arrangement of Fig. 69 is more commonly used, that of Fig. 68 being occasionally employed for small wheels.

Feathering Paddle-wheel.—A paddle-wheel in which the floats are of the *feathering* variety. See above.

With regard to the powering of naval vessels, Engineer-in-Chief George W. Melville, U. S. N., has expressed a preference for triple screws, with three independent sets of engines, the central set to be of greater power than those at the sides. He will read a paper on this subject before the British Institution of Naval Architects in London.

The new Hamburg-American twin-screw passenger and freight steamship *Patricia*, of the intermediate type, has been launched at Stettin. She is 560 ft. long and 62 ft. beam. The *Patricia* is about 13,000 tons register. She has a double bottom, extending the whole length of the ship, in twenty-four compartments. The vessel has accommodations for 205 first- and 126 second-class passengers, and 1,000 in the steerage. The cargo capacity is 12,500 tons. She will have a sea speed of about 12 knots.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—What would you do if the go-ahead eccentric slipped on the shaft? Would it make any difference to the go-ahead motion if the backing eccentric slipped on the shaft? Could either of them be reset correctly without removing the steam chest cover? What effect has linking up on a slide valve? Does it change the throw of the valve? How does it affect the cut-off? Why does an inspirator throw water into a boiler against its own pressure?

MASS.

A.—If the go-ahead eccentric slips, the natural remedy is to get it back into place. If it is keyed on the shaft this should not be a difficult job, as the parts of the keyway in the shaft and eccentric will show when they come together that the latter is in the correct position. If the eccentric is secured by set screws, as is occasionally the case, it will probably be necessary to take off the valve chest cover in order to set the eccentric in its exact position.

If the backing eccentric slips, it will make no difference when the link is in full gear; that is, when the motion of the valve is obtained entirely from the go-ahead eccentric. When linked up, however, the valve receives its motion partly from one eccentric and partly from the other, and the slipping of the backing eccentric will introduce more and more disturbance as the gear is linked up farther and farther from the full gear.

With the help of an indicator, yes; without, not very exactly unless the covers were removed. To make a rough setting in a hurry, without removing covers, put the engine on the center and shift the eccentric sheave to about its proper position ahead of the crank in the direction of motion. Put the link in full gear and then open the indicator cocks top and bottom and blow through. If no steam comes out your valve needs a little lead on that end. When you have given this, secure the eccentric, then turn the engine on the opposite center and blow through again. By comparing the amounts of steam passed, you can set the valve so that the engine will work. A leaky piston would give steam at both ends, but you can readily get the required results by observation.

The effects of linking up are as follows: The throw of the eccentric, the travel of the valve and the port opening are decreased. The cut-off is earlier. The lead is increased or decreased or kept constant according to the character and arrangement of the gear. With a Stephenson link fitted with the eccentric rods *open* (not crossed the one over the other when the crank is on the lower center), the lead is increased as the gear is linked up. The exhaust opening is earlier. The exhaust closure is earlier, and the compression is greater.

An inspirator throws water into a boiler against its own pressure for much the same reason that the feed pump forces water into the same boiler, also against its own pressure. In the latter case the total resistance or load on the water plunger is overcome by making the steam piston decidedly the larger of the two. This gives a total push much greater than the total resistance, and the water goes in. The present limits will not allow of a detailed explanation of the operation of an inspirator or injector, and while its operation is quite different in detail from that of the pump, there is yet a broad similarity at the bottom. To put the matter in one sentence, the inspirator forces water into the boiler because the heat energy in the steam used is converted into motion of the jet of feed water and condensed steam, and enough heat is so converted to drive this jet into the boiler against the steady pressure within. There are several good books on the injector in print.

Q.—Please give me a rule for figuring out the strength of a reinforcing ring on a manhole of a boiler.

A SUBSCRIBER.

A.—There is no regular rule for figuring the dimensions of the reinforcement ring. It is a matter which is determined by experience and practice rather than by mathematics. The ring is usually made of about the same thickness as the shell of the boiler, and should not be less in width than from three to four times the thickness. This will allow sufficient width for a single row of rivets, which should be spaced about the same as for a single riveted lap-joint.

Q.—What is the "equivalent girder?" How is it obtained, and to what use is it applied? **CUBITT.**

A.—The stress on the structure of a ship at any given cross section is directly proportional to the moment of the external forces about that section, to the distance of the fiber in question from the horizontal gravity axis of the cross-sectional area of the material furnishing longitudinal strength, and inversely to the moment of inertia of the same cross-sectional area about the same axis. The term *equivalent girder* is applied to a method of massing the structural material of the ship in such way that it shall resemble a more or less complicated form of I-beam section. That is, the decks, bottom plating and other horizontal members are massed in horizontal rectangles, while the side plating and other vertical members are massed in vertical rectangles, thus transforming the somewhat irregular structural cross section into a more regular combination of rectangles forming a section consisting of horizontal flanges and vertical webs. The strength of the ship is then considered the same as that of a girder having such a section and subject to the same external forces. From this section we may then determine the moment of inertia referred to above. The formation of this section was thus an intermediate step in the determination of the moment of inertia of the cross section of the structural material, and served further to show to the eye in a general way the manner in which the material was distributed through the cross section.

It may be noted that the construction in this way of an equivalent girder is a wholly unnecessary operation. The method of massing the material is to some extent quite arbitrary, and if measurements to scale are taken directly from the girder section for purposes of computation, the latter will necessarily contain a certain amount of instrumental error. The moment of inertia can be quite as satisfactorily obtained from the scantling cross section itself by taking in order each piece, of area as given by its dimensions, and treating it as a small rectangle of height equal to that which the piece covers. These operations arranged in tabular form furnish an orderly and reliable mode of obtaining the moment of inertia without constructing the equivalent girder as an intermediate step. It is true that the number of items in the computation is greater than with the equivalent girder, but the time required to make the construction and the possibility of error, as before referred to, are avoided. Limits of space prevent a detailed account of the various operations required to carry out this computation, which, of course, involves an extensive use of mathematics.

Q.—Please inform me how to get the tonnage of a launch 50 ft. long, 9 ft. beam and 6 ft. deep; also what is meant by displacement, and how to figure it out. What is the meaning of gross and net tonnage of a boat? **W. C.**

A.—*Tonnage* refers to the internal capacity or volume of a ship.

Gross Tonnage is the entire internal capacity measured according to certain rules specified according to the size and type of vessel.

Net Tonnage is the remainder after having taken from the gross tonnage certain allowances for crew space, engine and boiler rooms, shaft alley, etc.

Displacement is the weight of the water displaced by the ship, or what is the same thing, the weight of the ship itself and everything on board. Hence displacement varies from day to day, or from one voyage to another, while tonnage, being determined simply by the type and internal dimensions of the ship, is constant. Tonnage is supposed to represent a ship's earning capacity, and hence it usually serves as the basis for port and navigation charges. Tonnage cannot be found without taking actual measurements from the ship itself. The rules will be found among the navigation laws of the United States, or see Revised Statutes, Chap. 1, Title XLVIII, Sections 4150 to 4153, and Chap. 398.

Q.—What are the advantages of a compound engine over a simple engine? **C. H. L.**

A.—The chief advantage of the compound over the simple engine is in its greater economy. Other things being the same, it requires less coal to develop a horse power with a compound than with a simple engine. A large part of the loss in the steam engine is due to the condensation of steam on the internal surfaces of the cylinder, cylinder head and piston, during the admission period. This loss in the compound is only about one-half what it is in the simple engine, and there is a corresponding gain

in economy. In a still more marked degree this loss is cut down by the triple- and quadruple-expansion engines. Where a simple engine will give a horse power for from 3 to 3 1-2 lb. of coal we may expect that a compound will give the same power for from 2 to 2 1-2 lb., a triple for 1.8 lb. or less, and a quadruple for 1.5 lb. or less. The detailed explanation of the causes of this gain would occupy more space than we can give here.

Another point which may be mentioned is that the compound marine engine has usually two cranks and gives therefore a more uniform turning effort on the shaft than a single engine. This result might, however, be attained by the use of two simple engines, so that it is not a necessary advantage of the compound system, but rather a result which naturally goes with that type. With the triple- and quadruple-expansion engines the crank effort is similarly made still more uniform, by the additional cranks distributed uniformly around the circle.

Q.—Given length, beam and draught of hull, and diameter, pitch and revolutions per minute of propeller, how can the approximate speed of a vessel be determined? What is the usual pitch of propellers for launches, both solid and reversible? **DUNRAVEN.**

A.—The speed of a ship depends on her length, beam, draught and form, together with the I. H. P. and propeller efficiency. You do not refer to the I. H. P. in your question, though it is naturally one of the fundamental quantities upon which the speed depends. So far as the dimensions of the propeller are concerned, and assuming that it is working at a fair efficiency and an apparent slip of 15 to 25 per cent, an approximate value of the speed would be found by multiplying pitch by revolutions, the product by (1 — slip ratio), and reducing the result to miles per hour by dividing by 88, or to knots by dividing by 101.3. Thus with pitch 3 ft., revolutions 300 and slip .20, the speed would be given in miles by:

$$V = (300 \times 3 \times .80) \div 88 = 8.18.$$

There is no possible answer to your last question regarding the usual pitch of launch propellers. From 18 in. to 5 ft. will cover the usual range of values.

Q.—What would be the proper amount of lead for a slide valve on a steeple compound 24 in. and 42 in. by 30 in. engine used in a tug for heavy towing and turning about 84 revolutions per minute? **H. D. W.**

A.—The information you give is insufficient as you say nothing about the valves, size of ports, etc. As a guess we would say that 1-8 in. lead would probably be correct in the case you mention.

Obituary.

Chief Engineer Robert R. Leitch, U. S. N., retired, died on March 14 at the Brooklyn Hospital after an operation for appendicitis. He had been ill but four days. Mr. Leitch was forty-nine years old. He was graduated from Annapolis in the class of '71 and stood at its head. He was appointed Second Assistant Engineer in January, 1874, Assistant Engineer in February, 1874; Passed Assistant in January, 1879, and Chief Engineer in September, 1894. He was retired in 1896 on account of ill health. At the beginning of the war he re-entered active service and was assigned to duty at the Pensacola Navy Yard. He leaves a widow. The interment took place in Baltimore, the birthplace of the deceased.

Assistant Naval Constructor Robert Dashiell died in Washington, D. C., March 8 of cerebro-spinal meningitis, after being ill three days. He leaves a widow and three young children. Mr. Dashiell, who was graduated from the Naval Academy in 1884, was an ordnance expert, and also an authority on the subject of docks.

In these days of foreign service the constant transfer and change of residence of officers of both the Army and Navy makes it difficult for persons interested to follow their movements. Of great assistance in this respect are the lists published in the *Army and Navy Journal* of New York each week. They are manifestly prepared with great care and are the most complete in periodical form.

RECENT PUBLICATIONS.

LA GUERRA DEL 190— (The War of 190—). Lega Navale, Spezia, Italy. Size, 8 by 11. Pages, 75. With many illustrations. Paper covers.

This little book adds another to the list of imaginary wars written usually for the purpose of impressing upon some people or government the need of a more active military or naval policy. In the present case Italy and France are the combatants, and the book is written from the Italian standpoint in order to show the need of a more powerful navy if Italy is to hold the place among her neighbors which is her due. The cause of the war is simple and is readily found. The *Triple Alliance* is supposed to have been sometime broken, and Italy is left without formal ally. An aggressive French colonial policy and a restriction of the rights of Italians in French colonies leads to strained diplomatic relations between the two countries. Soon a collision occurs on the frontier and by natural steps, in which modern sensational journalism takes no small part, the situation results in a declaration of war. The story of the war itself is told in a series of letters between the captain of the Italian flagship *Benedetto Brin*, his wife, his nephew, who is an officer of the general military staff, a friend who is captain of the Italian battleship *St. Bon*, and a friend who is a member of the Chamber of Deputies. By this means descriptions are given of the chief events, including an attack on Spezia, the bombardment of Genoa and Naples, the attack of the Italians on Biserta, where the exit of French war and merchant ships is prevented by sinking in the channel a large French liner, the *St. Jacques*, recently captured by a torpedo-boat destroyer, after the manner of the *Merri-mac* at Santiago. The chief naval battle is that of Cape Caccia, in which the Italians are successful, but at severe loss. This is followed by final disaster at the hands of the French northern fleet hitherto held in reserve. Questions of tactics, of naval discipline and of the relations between the naval and legislative powers of a government are discussed in a familiar and pleasant manner, while the purpose of arousing Italy to the necessity of a more vigorous naval policy is kept clearly to the front. Copious illustrations are given of leading ships in both the French and Italian navies.

"The Practice and Theory of the Injector," by Strickland L. Kneass, C. E., is without doubt the most comprehensive and practical treatise on the subject, and we are glad to note the publication of a second edition, with additions and revisions to date. In this book, while the history and theory of the instrument receive ample attention, it is written from the standpoint of the "practical man" in full and complete touch with his subject rather than from the standpoint of the theorist. In the treatment of the subject after developing the principles involved and pointing out the essential elements of the apparatus, the author dissects it, taking up the various tubes and studying their functions separately and in detail. This leads to a consideration of the injector as a whole, and then there are also notes on the selection, the determination of size, and matters of repair. The suggestions for determining the causes of failure are sufficiently explicit to enable any one with ordinary mechanical skill to diagnose any common ailment and to apply the proper remedy. In fact there is little that the working engineer desires to know about the injector that cannot be found in this book. It contains 158 pages, with many engravings and drawings, and is published by John Wiley & Sons, New York; price, \$1.50.

The name of President Hill, of the Great Northern Railway, has been associated with a project to establish a new line of steamships to trade between Seattle, Yokohama, Hong Kong and Vladivostock.

TRADE PUBLICATIONS.

A neat folder, on the front of which is a fine cut of the yacht *Susanne*, is issued by Wilson & Silsby, announcing the removal of their lofts to new quarters especially prepared for them in the north side of Rowe's Wharf, Boston, Mass.

A pocket size slip, upon which is printed a large picture of a compound engine, is sent to all users who are interested in the marine engine, by Nelson W. Twiss, New Haven, Conn. The cut gives a very good idea of the general construction of the Twiss engine.

"Incrustation and Corrosion" is the title on a pocket size paper bound book issued by the Pittsburg Boiler Scale Resolvent Co., Pittsburg, Pa. Those of our readers who have any trouble with boilers and who are interested in the subject of scale and corrosion will find a copy interesting reading.

"Mechanical Draft" is the subject treated in a very neatly printed 8-page pamphlet in two colors, issued by the Sturtevant Co., Jamaica Plain, Mass. Although the matter is stationary rather than marine, it will still be of much interest to many of our readers. Copies can be had by applying for them.

"Electric Welding" is the title of a very neat catalogue printed in two colors and sent to all inquirers by the Standard Tool Co., Cleveland, O. The paper cover is finely illuminated in silver and printed in red and dark green. The book is devoted very largely to describing samples of welding which are illustrated with much taste.

"The Teachers' Note Book," just issued by the Joseph Dixon Crucible Co., Jersey City, N. J., should be in the hands of every reader who wishes to enjoy a good laugh and at the same time have at hand important information regarding lead pencils. The subject matter is very skillfully put together and will interest every person who uses a lead pencil.

"Facts on Boilers" will be sent by the Sumac Co., Ltd., Wilder Building, Rochester, N. Y., to all inquirers who are interested in the subject of the care of boilers. This folder gives information regarding the cause of boiler explosions and other troubles, and tells in a few words what the Sumac boiler compound is and what it is designed to do.

A circular is received regarding the new gasoline engine which is being put on the market by Thomas P. Benton & Son, LaCrosse, Wis. This engine is of the vertical two-cycle type, and is fully illustrated, the several illustrations showing the engine from the smallest size up to 40 horse power. Further information can be had by writing for copies of these circulars.

Bundy steam specialties receive much attention in a 40-page catalogue just issued by the manufacturers, A. A. Griffing Iron Co., Jersey City, N. J. These specialties include return steam traps, steam and oil separators, separating steam traps, etc. The catalogue is neatly printed on good paper and the several devices fully illustrated, giving altogether as much information as could well be asked for.

"A Bird's Eye View of Our Business" refers to the Westinghouse Machine Co., Pittsburg, Pa., which is an unusually neat pamphlet printed in two colors and devoted to the Westinghouse engines. The several types and styles of engines are particularly well shown by fine half-tone engravings. These include several direct connected electric plants, which will be of much interest to many of our readers who have to do with electric lighting on board ship or in the shipyard. A good deal of information is given regarding the Westinghouse gas engine; also regarding the refrigerating process. Copies of this book should be in the hands of all of our readers, and may be obtained from the Pittsburg office or from Westinghouse, Church, Kerr & Co., 26 Cortlandt street, New York.

"Vessels Owned on the Pacific Coast and Hawaiian Islands" is the title of an 80-page paper bound book, 6 by 9 in. in size, issued by the Commercial Publishing Co., 34 California street, San Francisco, Cal. Many of our advertisers and readers who wish to send out circulars, or for other purposes wish to reach shipping people on the Pacific coast, will find this book of much value, as it gives a complete list of vessels documented at San Francisco, Puget Sound ports and all other ports on the Pacific coast of this country; also in Honolulu, the list being compiled from official sources. The price is only 25 cents. Copies can be had from the Commercial Publishing Co.

"Architects' and Engineers' Electrical Bulletin for February" is a very handsome publication issued by the Sprague Electric Co., 20 Broad street, New York. It comprises about 75 pages, 9 by 12 in. in size, bound in very handsome green paper cover which is printed in dark red and gold. The table of contents is varied and contains much valuable information, such as electricity as applied to automobile carriages, electric railways, electric heating, the running of exhaust fans, together with information on wiring practice, electric motors, generators, etc. Copies will undoubtedly be sent to all of our readers who write and mention Marine Engineering.

Graphite paint is very thoroughly discussed in a catalogue of 106 pages, 6 by 9 in. in size, and very handsomely printed on coated paper, issued by the Detroit Graphite Mfg. Co., Detroit, Mich. A good deal of information is given regarding graphite and the manner of preparing it for paint, and there is much detailed information regarding the subject of paint, especially that made from this mineral. About seventy-five pages of the catalogue contain large pictures of battleships, lake and other vessels, bridges and prominent buildings where paints and other graphite products of the Detroit company have been used. The first picture is a large and very handsome one of the Waldorf-Astoria hotel. Our readers will find this catalogue worth sending for.

"The Test of Time" is the title of a very handsomely published and illustrated catalogue of 64 pages, the fourth edition of which has just been issued by Ostermoor & Co., 116 Elizabeth street, New York. It contains a great deal of information regarding the patent elastic felt mattresses manufactured by this company. Many illustrations show the different styles of mattresses; also pillows in many forms and shapes. Many testimonials from yachtsmen and others are given, and there is much information regarding the life-saving mattresses which this company manufactures. The mattresses are used in the Light House, Life Saving, Coast Survey and many other departments of the Government, as well as on many coast lines of steamships, lake steamers, Hudson river boat lines, etc. Particular attention is also given to a description of cushions and upholstery for yachts, a special advantage being that they can be used as life preservers. Copies of the catalogue can be had from the company by mentioning Marine Engineering.

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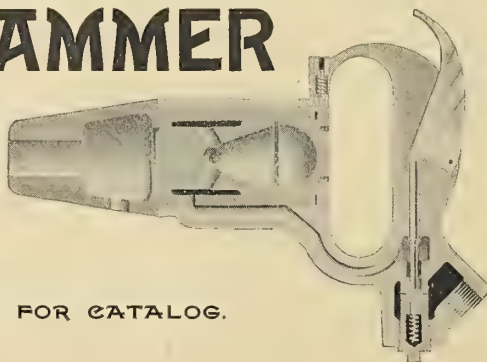
OUR VALVELESS HAMMER

Has the advantage over all other tools on account of its absolute simplicity, efficiency in operation and immunity from aggravating expensive repairs.



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There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite**. It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N.J.

The advantages of the Mississippi safety water-tube boiler are set forth in much detail in a catalogue just issue by the Mississippi Safety Water-Tube Boiler Co., 904 Olive street, St. Louis, Mo. This is one of the recent boilers in the marine field, and special attention is given in this catalogue to the question of circulation, dry steam, accessibility for repairs, economy, light weight, etc. A number of pictures tell plainly the general construction of this boiler.

"Hardening for Business and Hard Facts" is the title of a pocket sized pamphlet issued by Loring, Coes & Co., Worcester, Mass. It is devoted especially to the pyro-calcic hardening and annealing process adopted by this firm. The pamphlet is very neatly illustrated and printed in two colors. The text gives a good deal of information regarding the hardening process and the results obtained. This process can be applied to special tools and to almost any kind of metal.

"Pantasote," stamped in gilt on a Pantasote bound pamphlet, is descriptive of the peculiar quality of this material. Pantasote is especially adapted for upholstering cushions and furnishings on board yachts and ships and for a great many other purposes, including the binding of books and other uses which are told of in this pamphlet, which is lithographed in three colors. Copies of this pamphlet and more detail regarding the material can be had from the Pantasote Co., 29 Broadway, New York.

Yachtsmen and others interested in the subject of an engine that is simple and easily handled will want to send for a catalogue of the Knickerbocker, manufactured by the Knickerbocker Engine Works, Hartford, Conn. This engine is made either simple or compound, as described and fully illustrated in the catalogue, and needs no more attention than to see that oil is in the oil cup when the engine is started. As shown in the advertisement of this company, the engine is controlled entirely by a lever in the pilot house.

"Steel Plate Fans" is the title of a catalogue of 132 pages, of which the B. F. Sturtevant Co., Jamaica Plain, Mass., has found it necessary to issue a second edition. As its title indicates, the catalogue is devoted to the subject of fans, and all kinds of blowers are shown in these pages, with many diagrams and tables regarding capacity, etc. The subject matter will interest many of our readers who are interested in the subject of mechanical draft or the ventilation of holds or buildings.

"The Bullard Book" is a beautifully printed 7 by 10 in. catalogue devoted to machine tools manufactured by the Bullard Machine Tool Co., Bridgeport, Conn. The printing and engraving are of the very highest quality. The subject matter is in two colors, and the book is bound with a silk cord, with a handsome cover printed in two colors. Any one of our readers who is at all interested in boring and turning mills should have a copy for reference, as illustrations and descriptions are given of about a dozen types and sizes of these mills, together with other information regarding them.

Two catalogues are received from the International Correspondence Schools, Scranton, Pa. One, entitled "Your Chance Has Come," tells of the training that a number of men have secured through this school in mechanical draughting so as to secure better positions for them or bring increased salaries in their present positions. The subject of mechanical drawing is one that will interest many of our readers, and undoubtedly those who are seeking information in this line may know some of the men this catalogue speaks about. The other catalogue gives a brief description of short courses in these schools in mechanical and ornamental drawing, bookkeeping, stenography, etc.

The death is announced of Edward Smith Taber, president and treasurer of the Morse Twist Drill & Machine Co., New Bedford, Mass., since 1868, at the age of 73 years. Mr. Taber's business career and that of this company are practically identical, and no greater tribute to his business ability could be paid than the simple announcement that his business grew from small proportions to one of the greatest and most widely known of its kind, not only in this country, but abroad. Mr. Taber was not merely a figurehead, but took active part in the business of the company. As a representative business man, Mr. Taber was also connected with several of the leading financial and other institutions of New Bedford. His death will be widely regretted by a long circle of business associates and friends.

BUSINESS NOTES.

ELECTRICAL EXHIBITION.—An electrical exhibition is to be held in Madison Square Garden, New York, from May 8 to June 3. Many of our readers who have mechanical devices in any way adapted to electrical work and wishing to make exhibition should apply to Marcus Nathan, at the Garden building.

A NEW LAUNCH CONCERN.—The Western Gas Engine Works, which formerly had a small plant in Grand Rapids, Mich., have removed to Mishawaka, Ind., and established a large plant, where not only gas engines will be built but a full line of yachts and launches can be supplied. This concern will make a specialty of a 16-ft. launch which will be within the reach of all so far as price is concerned.

THE DEANE PUMPS.—The Deane Steam Pump Co., Holyoke, Mass., reports many orders lately for pumps of various kinds, among such being orders for two large vertical ballast pumps for the new steamer which the Union Dry Dock Co., Buffalo, N. Y., has on the ways. The Deane company also received the order for the outfit of pumps for two large steamers which are being built for the North German Lloyd Co., at Bremen, Germany. This order includes horizontal, duplex, bilge, feed and vertical ballast pumps.

MONITOR VAPOR ENGINES AND LAUNCHES.—C. B. Sterling & Co., 120 Liberty street, New York, have made arrangements to represent the Monitor Vapor Engine Co. This concern has an exhibit in its office of a Monitor engine and now has an order on hand for a 40-ft. launch which will be fitted with a 16-horse-power mogul engine. Catalogues and other information sent to all inquirers.

ARTISTIC BRASS WORK.—J. J. Ryan & Co., 68-74 West Monroe street, Chicago, Ill., who claim to be the largest jobbing brass founders in the country, and who also manufacture a line of babbitt metals in addition to a full line of brass and bronze work for marine purposes, have just completed a very effective medallion and series of panels in bronze to be placed on a monument in Kansas. This order shows the scope of the work which this firm undertakes.

THE BACHELDER INDICATOR.—Attention is called to the advertisement of Richard Thompson & Co., 120 Liberty street, New York, who sell the Bachelder adjustable spring indicator, which, with the Ideal reducing wheel, makes a complete indicator outfit. This was first brought out about eight years ago by Mr. Thompson, and has lately been fitted with all the latest improvements, parallel motion, drum spring, etc. Full information can be had by writing.

COLD GALVANIZING PROCESS.—We are informed that the Standard Oil Co. has adopted a cold process for galvanizing in its works at Bayonne, N. J., replacing the old style of doing this work. This indorsement of the cold process is very gratifying to the owners of the process, the U. S. Electro-Galvanizing Co., 346 Broadway, New York. This company is now selling rights to introduce the system. Full information can be had regarding it by writing to the company.

TO FILL UP CHECKS.—A composition designed especially for filling up and smoothing over checks and cracks in masts, booms and other wood work is offered by Cole & Kuhls, foot of Twenty-fourth street, Brooklyn, N. Y. This composition has been used on many of the best-known yachts and vessels in the country, and the fact that duplicate orders have been received in many instances is significant. This composition is not affected by temperature, as it shrinks and expands with the wood. Any one interested in the subject can secure full information, with sample enough for a test, by writing to the manufacturers.

SHEAVES WITH METALINE BUSHINGS.—The Boston & Lockport Block Co., Boston, Mass., informs us that it has been compelled to make a large addition to its plant in East Boston, both in building and machinery. This enables the company to carry a larger stock, and to execute orders for special blocks with greater facility than before. The coming year will be the twenty-fifth anniversary of the introduction of the celebrated metaline bushings into block sheaves, shown in the advertisement elsewhere. As business improves the company notes a change from the cheaper class of blocks to a better class, which seems to be encouraging, since any attempt to reduce the standard strength and quality of such an article as a block ought never to have favorable consideration.

TWO PAINTS IN MARINE PAINTING.

The kind of paint used on a ship's hull and its effect upon marine growths are important considerations, bearing upon the ship's speed and thus, directly, upon its earning capacity.

That paint which presents the smoothest surface, least retards the motion of the ship through the water and affords the poorest lodgment for marine growths.

Of all the oil paints there is but one which retains its gloss and its smooth surface in the presence of salt water, and that is **Zinc White**. Red Lead (the old favorite), has but little gloss when first applied and quickly decays, but if the red lead be combined with a fair proportion of **Zinc White**, the coating obtained is smooth and glossy and remains so. Any other marine paint is similarly improved by the addition of **Zinc White**.

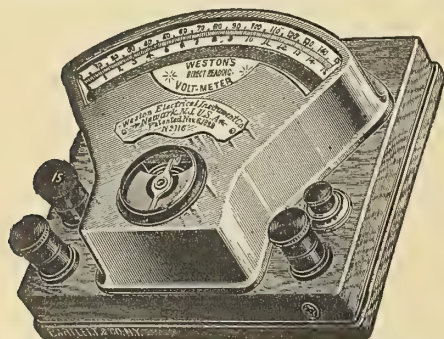
For ships' interiors, it is generally recognized that no other pigment will hold its color. **Zinc White** is an essential constituent of all marine paints, whether for interior or exterior use.

THE NEW JERSEY ZINC COMPANY,
52 Wall Street, New York City.

ADVT.

MARINE ENGINES.—Attention is called to the advertisement of the Morris Machine Works, Baldwinville, N. Y., which build a line of high-speed simple and compound engines from three-horse-power upward. The intention of the builders is to secure a staunch engine and at a price within the reach of all. This concern also makes a full line of centrifugal pumps for all purposes. Many pumps of this make are used in the U. S. Navy.

A BUSY SHOP.—The Columbia Engineering Works, Imlay and William streets, Brooklyn, N. Y., report the past year as one of the busiest ones in the history of the establishment. This company thoroughly overhauled the U. S. army transport Berlin, and did a great deal of work on the Mississippi. One of the latest jobs was extensive repairing to the S.S. Catania. This comprised overhauling machinery and boilers, fitting on new funnels and doing other work. This establishment also fitted the Munson liner Ardanmhor for a cattle ship, and is overhauling the tramp steamships Thomas Melville, Lauenberg and Birchtor.



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DIRECT READING

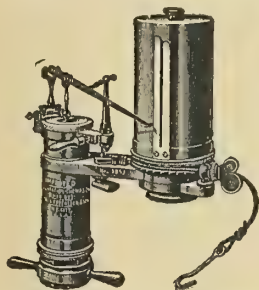
VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Instruments are recognized as **THE STANDARD** the world over. Our **VOLTMETERS** and **AMMETERS** are unsurpassed in point of extreme accuracy and lowest consumption of energy.

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HAVE YOU TRIED IT? EUREKA!!!

Many Engineers say it wears fully 3 times longer than any other, and keeps the rod in splendid order. If you use a flexible PACKING, it will pay you to try EUREKA. We are sending out a tony photo on 8x10 cardboard for one 2 ct. stamp.



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Jas. L. Robertson & Sons

218 Fulton St., NEW YORK.

Branches { BOSTON
PHILADELPHIA

A NEW METAL POLISH.—A new metal polish is offered to the public by the Alco Vapor Engine Co., Jersey City, N. J. This polish leaves an oily finish on whatever metal it is applied to, protecting it from the action of salt water.

THE INDICATOR.—Almost every marine engineer knows the value of an indicator and will appreciate the many new features which have been adopted in the Robertson-Thompson indicator, manufactured by James L. Robertson & Son, 218 Fulton street, New York. This firm is always ready to interest inquirers and give information relating to these indicators.

A LARGE LAUNCH WITH GAS ENGINE.—The Racine Yacht & Boat Works, Racine Junction, Wis., has nearly completed a 47-ft. launch for Quebec parties which is designed to make 12 1-2 miles an hour. It is equipped with a 20-horse-power gas engine, and will have a 32-in. wheel. Besides large launches with gas engines this company makes a specialty of everything in the way of boats or launches.

REFRIGERATING MACHINERY

FOR MARINE SERVICE.

We make a specialty of contracting to furnish everything that is necessary for complete refrigeration and ice-making plants. Our belt driven compressor is unequalled. We also build steam and gas engines and mechanical draft apparatus.

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COMPLETE PLANTS

& Mfg. Co.,

PITTSBURG, PA.

And all Principal Cities in U. S. and Canada.

Westinghouse Electric Co., Ltd.

32 Victoria St., London, S.W. England.

PUMPS FOR THE "MAINE."—In addition to the order for pumps for the Russian war vessels which the Cramp Shipbuilding Co. recently placed, the Snow Steam Pump Works, Buffalo, N. Y., have received the order for an outfit of pumps for the battleship "Maine." These include pumps for all the various uses on the ship.

MACHINE TOOLS.—A full line of machine tools for both wood and metal working is offered for sale and is always on exhibition by J. W. Cregar in the machinery department of The Bourse, Philadelphia, Pa. This is a special machinery sales agency, and includes the tools of most of the leading builders of the country. Mr. Cregar can supply a complete outfit of tools, from a small repair shop on board a ship to the equipment of a large shipyard.

NON-MAGNETIC WATCHES.—Every engineer will appreciate the possibility of damage to a high-grade watch on board ship or elsewhere where electricity is used, and will, therefore, be interested in the non-magnetic watches offered by A. C. Becken, 103 State street, Chicago, Ill. These watches are not only so constructed that they cannot be affected by electricity, but they are "adjusted" to temperature and have many other of the special features of the high-grade watches. They are sold at a very moderate price. Circulars and full information regarding them can be had by writing to the manufacturer and mentioning Marine Engineering.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

SHIP DRAFTSMAN SEEKS POSITION.

A college student who has had experience as a ship draftsman desires a position. Address "DRAFTSMAN," Station A, Boston, Mass.

SALESMAN WANTED.

A prominent petroleum refining company desires the services of a competent man to sell oils for marine use. Good position to the proper party. Address "S," care MARINE ENGINEERING, World Building, New York.

LAUNCH HULL FOR SALE.

A launch hull for sale; in first class order, one year old, 25 feet over all, 5 feet 6 inches beam, 23 inches draught; suitable for gasoline or steam engine. Address, J. F. ROGERS, 2605 Claremont Ave., Chicago, Ill.

BARGAIN IN STEAM YACHT.

A fine yacht, 50 feet over all. Able seaboat, compound engine, water-tube boiler, quarter boats, awning, and everything complete; for sale at a great bargain.

STEAM YACHT, care MARINE ENGINEERING, World Building, New York.

A THOROUGH SHOP MAN SEEKS ENGAGEMENT.

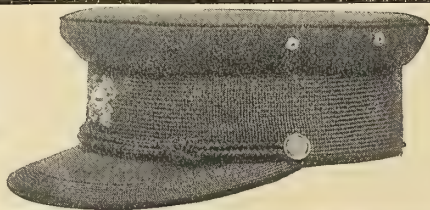
A man who has made a practical study of shop accounts and is able to show daily cost of all work in hand, will soon be open for an engagement. The advertiser is known as a successful engineer; is able to take entire charge of an engineering business where first-class work is required. He is acquainted with the requirements of governmental work. He leaves his present business as he differs in a friendly way from his associate as to future policy; is a thorough shop man. Address "ENGINEER," care of MARINE ENGINEERING.

THE BEST....

**CAPS,
EMBLEMS,
UNIFORMS.**

WARNOCK

New York,
19 & 21 W. 31st St.



THE TAYLOR WATER-TUBE BOILER.—The late owner of the yacht Azalea, in a letter to the Detroit Screw Works, Detroit, Mich., refers to a "brush" with the fast steamer Frank E. Kirby, and said: "The fact is that we just played with the 'Kirby' all the way from Put-in-Bay. To judge from the rapid way in which we left her on the 'homestretch,' my opinion is that we can beat her at any time, barring accidents, and the way the Taylor boiler steamed when we put the blower on full was a caution."

BETHLEHEM AS AN INDUSTRIAL CENTER.—The Board of Trade of Bethlehem, Pa., is making a most commendable effort to direct attention to that city as a site for industrial works, where metal working especially can be carried on to much advantage. The place is already well known as the home of the great Bethlehem Iron Works, where so many beam forgings have been made for war and merchant vessels. Manufacturers interested in this subject should write to A. C. Graham, Secretary of the Board of Trade, South Bethlehem, Pa., who can give information.

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School for
Mechanics

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Steam and Gas Fitting, Tin,
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Marine Work

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In use for more than two years with best and absolutely satisfactory results. Articles that cannot be galvanized by any other process, such as screws, nuts, cutting instruments, tools of every description, springs, locks, artistic metal articles, can be galvanized in a superior manner by this process. The multitude of articles that can be galvanized is without limit. Uniformly smooth surface is preserved, thickness of coating can be regulated, saving of spelter about 80 per cent., besides many other advantages. We grant licenses for territory, also shop rights on royalty basis. GALVANIZING DONE AT OUR PLANT, 9-11 Franklin St.

U. S. ELECTRO GALVANIZING CO., 348 Broadway, New York.